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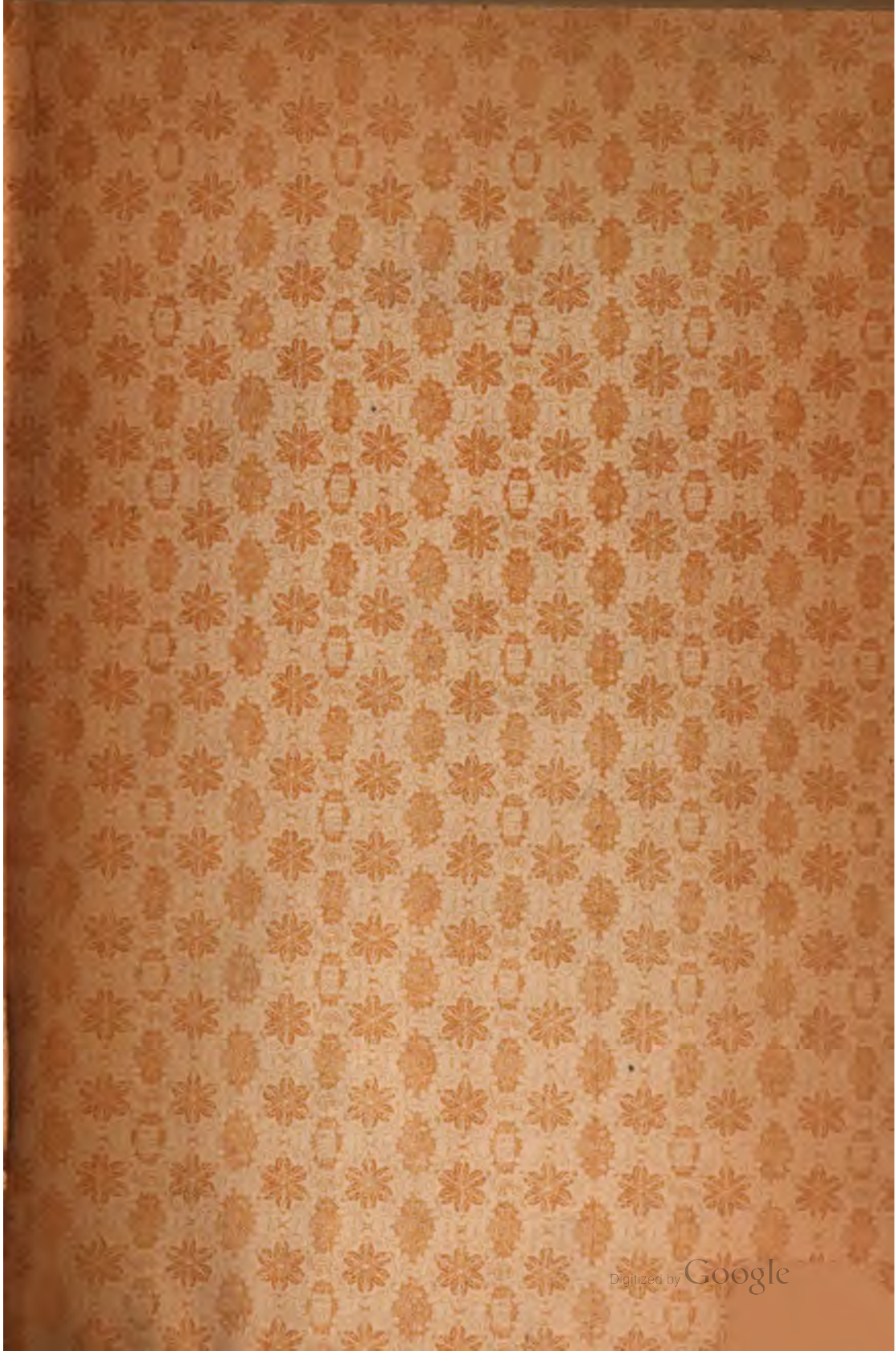
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PROCEEDINGS

OF THE

THIRD ANNUAL CONVENTION

OF THE

American Railway Engineering  
and Maintenance-of-Way  
Association

HELD AT THE

AUDITORIUM HOTEL, CHICAGO, ILLINOIS

MARCH 18, 19 AND 20, 1902

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VOLUME 3

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1902

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GEORGE W. KITTREDGE, PRESIDENT.





L. C. FRITCH, SECRETARY.



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# PROCEEDINGS

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**This Association is not responsible, as a body, for the opinions or views expressed by individual members.**

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**TUESDAY, MARCH 18, 1902.**

The meeting was called to order promptly at 9:30 a. m. by the President, Mr. George W. Kittredge.

The President:—Our attendance does not seem to be very large, but we hope our members will come in very shortly. If the gentlemen who are present will be patient for a few minutes, we will begin the proceedings with very little delay.

(Intermission of ten minutes.)

President Kittredge:—Although it is not stated in the record of our proceedings, I feel that I must admonish our members that, being railroad men who appreciate the value of keeping on schedule time and the necessity for it, our meeting hour in the morning is 9:30 o'clock, and in the afternoon at 2 o'clock. I trust all the members will bear these hours in mind, and be here promptly.

In the regular order of business, the first item is the reading of the minutes of the last meeting. This refers to the proceedings which have already been printed, and, following the custom of previous years, we will consider that the minutes of the preceding meeting are approved, unless objection is made.

There being no objection, the minutes will stand as accepted and approved.

The next thing in order is the address of the President. It seems to me, inasmuch as the address has been made one of the features of the proceedings, that some consideration should have been given in selecting the President, and this fact and his ability to make an address should have been considered; but inasmuch as the Association is responsible for the present incumbent being in

office, the Association must bear the blame if his address is not a work of art.

### PRESIDENT'S ADDRESS.

*To the Members of the American Railway Engineering and Maintenance-of-Way Association:*

Gentlemen:—We should experience feelings of pleasure and gratification at our meeting in this our third annual convention. We can congratulate ourselves upon having had a healthful growth and upon being in good condition financially. The Secretary's report shows the status of the year's membership—the new members elected, those who are deceased, those who have resigned, and those who have been dropped for non-payment of dues. It is one of the things to be regretted that some members fail to pay their dues, and therefore have to be dropped.

A perusal of our roll shows that we have with us members from Russia, Japan, Australia, Canada, Mexico, England, New Zealand and Central and South America.

Your Board of Direction have held frequent meetings during the past year, which have been reasonably well attended. They have tried to keep in touch with the work of the various committees, and, profiting by the experience of former years, have tried to get reports formulated in such a manner that only such branches or portions of subjects should be handled as could be fully considered and carried down to definite conclusions. Some reports must of necessity be reports of progress; but so far as it has been practical to do so, you will this year find that the reports contain a certain number of conclusions upon which you can, as a body, act. Efforts have been made to have the reports so handled that they shall truly be the reports of committees, and not of individuals.

It was contemplated that all of them should be printed and distributed a considerable time before the meeting, so that members would come here prepared to discuss them intelligently and without waste of time. Circumstances beyond the control of the members themselves, or of your Board of Direction, have made it necessary to appoint new chairmen on several of the committees. In some cases the vice-chairmen were able and willing to carry on the work without much loss, while in others it was necessary to seek diligently and long to properly fill the vacancies. It has developed that considerable time is absolutely needed to get reports printed, especially so if they contain tabulated statements or drawings. These circumstances have conspired to delay some of the reports longer than was desirable; but we feel that an improvement has been made, and shall hope for still greater improvement in the future.

We have found in dealing with our committees what we so often find in carrying on our daily work—that there are two kinds of leaders: the one kind that can and does do most of the work itself, and the other kind that can make someone else do it; and here, as is usually the case

when measured by results, the latter is the smarter. It is within the power of those who have reports in charge to wield a great force, and its duties should be entered upon soberly and advisedly.

This Association has a right to expect a complete, full and prompt handling of the subjects submitted, and it should not be satisfied with anything less.

It is encouraging to feel that the high executives of the railways look with favor upon our organization, and with interest upon our meetings, discussions and publications. The year 1901 has been a very busy year with most of us, and it is during busy years that the work of the Association should be of most value. We have with us men who stand high in our profession, who have had most valuable experience in all kinds and grades of work. Through our meetings, discussions and publications, opportunities such as were never before offered are given for the dissemination of knowledge pertaining to our particular branches, and of the results of carefully studied and worked-out methods. Our publications should become the text-books for maintenance-of-way work, and should be kept easy of access to those who strive to know what is considered good practice, and endeavor to conduct their business upon intelligent, systematic and economical lines.

We can safely predict an increasing appreciation as our work becomes farther advanced, and as the reports of our committees become complete in recommendations, and the Association puts its stamp of approval upon them.

That our Association had a successful birth was probably due to the ability and strength of those who conceived its existence. Its growth and success must be dependent upon the nourishment and support that it obtains through the coöperation and interest of its members primarily. It is encouraged by the friendly attitude of the higher officers of the railway companies, by the gratifying attendance upon its meetings, and by the interest shown in its discussions and publications.

In these days of accelerated time, of necessities for better and smoother riding track, of increased weights of power and rolling stock—each and all of which means directly or indirectly increased expenses in maintenance—what a fine opportunity is given for the Association to show its force and demonstrate its value by setting forth and endorsing methods that are effective and at the same time provide for the safe, expeditious and economical handling of traffic.

I recall with pleasure an evening spent some time ago—when my years of experience lay largely ahead of me—with three gentlemen of our profession, each an authority in his particular line. They were men whose services as experts were sought all over this country, and they were not unknown abroad. They discussed in a broad and intelligent way what the first President of our Association referred to as the proper relation of things, and each seemed to feel how small was the measure of success of any achievement along special lines that did not work harmoniously toward a desired whole. I walked to the hotel with one of them sometime

after 12 o'clock, and he remarked that he had gotten a great deal of valuable information from Mr. Smith that night. I had felt that my fund of knowledge had been greatly increased, and it raised hopes in my mind when I realized that a man as well posted as my companion had, too, been able to learn.

It should be our earnest wish and aim that our meetings, our deliberations and our discussions here may be conducted on a broad and intelligent basis, with calmness and with thoroughness, so that when we depart, the younger and the older ones among us may all feel that we have learned something, and that the decisions reached and the recommendations made are authoritative and of value to us in planning and carrying out our work so that the results may prove satisfactory to ourselves and to the railway companies whose interests we serve.

If we succeed in this, then indeed is our Association a success and its existence abundantly justified. [Applause.]

President Kittredge:—The next business is the report of the Secretary and Treasurer.

Secretary Fritch submitted the following report:

#### REPORT OF THE SECRETARY AND TREASURER.

Balance cash on hand last annual meeting, March 11, 1901.....	\$2,117 50
Receipts during the year.....	\$6,290 13
Expenditures during the year.....	6,030 23
	<hr/>
	\$ 259 90    \$ 259 90
Balance cash on hand.....	\$2,377 40

#### MEMBERSHIP.

Membership at the annual meeting, 1901.....	359
Members admitted during the year.....	60
Members deceased during the year.....	4
Resignations .....	3
Members dropped from rolls .....	6
	<hr/>
	13 13
Net gain .....	47 47
Membership date of annual meeting, 1902.....	406

#### DECEASED MEMBERS.

Since the last annual meeting, the Association has lost by death the following members:

J. F. KIDDER,  
J. T. MAHL,

G. A. QUINLAN,  
J. W. TAYLOR.

President Kittredge :—Gentlemen, you have heard the report of the Secretary and Treasurer. What is your pleasure?

Mr. F. H. McGuigan (Grand Trunk) :—I move that the report of the Secretary and Treasurer be accepted.

(Motion carried.)

President Kittredge :—The next item in the regular order of business is the reports of standing committees. I will ask that the committees follow the plan that was adopted last year, and which proved so successful, and that is, as the committee is called, the various members present will step forward and take places on the platform. In the discussions which follow I would ask that each member as he arises to participate in the discussions will announce his name and the railroad which he represents. This is a necessity where there are so many present, and particularly is it a necessity with your present Chairman, who does not remember names as long as he hears them. He now appreciates a remark which a man made to him, who said until he had children in his family he never knew why it was necessary to have two ears, but since he had children he found it was necessary for remarks to go in at one ear and out at the other. That is the way with me regarding names—they go in one ear and out the other. I remember faces very well, but not names, and I ask the members to announce their names and the railroads with which they are connected.

One word more in regard to participation in the discussions. I hope you will all feel at perfect liberty to discuss the matters which come before us in a perfectly free, frank and open way. Our Association can only hope for success as our discussions are animated and are indulged in by large numbers of our members. I do not know whether it is necessary to refer to one particular phase of these discussions. It has, in some cases probably, been felt by some of our members, particularly the younger ones, that if they took part in the discussions here they might not follow exactly the lines which would be approved by their superiors. While I have great faith in the superiors of younger men, I like to feel that this Association is an association whose existence depends on the discussions of questions which affect our business by its members, and that here the members should feel at perfect ease and freedom to discuss any question in any manner which to them seems proper.

The report of the first committee is that on Roadway, Mr. McNab, Grand Trunk Railway, chairman. The Secretary will call the names of the Committee, and as they are called, they will please step to the platform.

## REPORT OF COMMITTEE No. I.—ON ROADWAY.

*To the Members of the American Railway Engineering and Maintenance-of-Way Association:*

The scope of the work having been outlined in previous reports, the Committee has confined itself during the past year to the investigation of two important subdivisions of such work, and this, it is hoped, has been done in sufficient detail for the present to be of profit to the members of the Association.

In response to a communication from the Board of Direction, asking what portions of the general work the Committee would treat during the current year, it was reported that those relating to types for Standard Cross-Sections of Roadway, and the Improvement of Grades and Alignment would have preference; it being felt by the Committee, that by reason of the primary importance of these particular matters, the presentation of any information tending to the economical betterment of such, would be of immediate practical benefit to the railways interested.

It may be taken for granted that every railway on this continent has more or less of its physical features capable of considerable improvement, but it is unnecessary now to speculate upon the origin of defects—more especially of those relating to the class known as bad grades and alignment. Suffice it to say, that with the limited experience the earlier engineers had in the Economics of Railway Location, and their reasonable inability to foresee the extraordinary development of the commercial conditions of the country, with the consequent keen competition in transportation facilities, ultimate results were not given the consideration that to-day they receive.

## CROSS-SECTIONS OF ROADWAY.

Regarding Cross-Sections, stability is of primary importance in the design and construction of railway roadbed.

With the rapid increase in recent years in the intensity of moving loads to be sustained by railway embankments, in weight and speed, as well as in frequency of train service, heavier track construction has been generally adopted; and in order to insure greater resistance to the shock of moving trains, it appears as if a more substantial embankment than that heretofore built on the majority of the lines is required, in order to properly and economically maintain the track in the condition necessary for the service expected.

Stability of slopes in earth or kindred materials cannot be relied upon, where the angle of same with a horizontal plane exceeds the angle of repose for the particular material dealt with.

As the angle of repose differs for different kinds of material, and local features frequently obtain in modifying this angle, the slopes of embankments and cuttings should be varied to suit as nearly as may be practicable the materials of which they are formed, or of which the excavation is made, and local conditions taken into account in connection therewith.

Due regard should be given to this detail, not only in the construction of new embankments and cuttings, but also in the widening and reshaping of old ones, and discretion should be allowed, and good judgment required of the engineer, or other officer in charge, with respect to carrying it out.

Good practice, in the opinion of the Committee, prescribes a width of 20 feet at top of embankments for single track, standard gauge—that is, at subgrade—and this width is approved and recommended by the Committee for first-class lines with heavy and constant traffic. For double track, an additional width of 13 to 14 feet.

Arbitrary widths of 18 and 16 feet, respectively, are also recommended for less important lines, varying according to the general loads and volume of traffic reasonably expected.

In the theory upon which the width of embankments at subgrade is based, it is considered that the track in cuttings is placed upon what is virtually a low embankment, and in order to preserve uniformity of conditions immediately under the track throughout the line, the width of subgrade in cuttings should be made the same as on embankments, outside of which sufficient room must be allowed for side ditches.

In each of the classes of less important lines, when finances will warrant it, or where the excavation can all be used in embankments within reasonable haul, it is the opinion of the Committee that such similarity in width is also the proper thing.

In cases however, where the immediate financial problem is a governing element, or else where a large amount of excavation is necessary, in order to get proper ditches, it may be entirely practicable to narrow up the roadbed proper in the cutting. Not however, to a greater extent than to give two feet less in width than the top of a real embankment, and in such cases, the ditches should be turned off at the end of the cutting in approved manner, in order to prevent eating into the embankment.

The capacity of side ditches should be sufficient to pass easily the greatest amount of water that can come to them; and wherever necessary to be widened, such increase should be made on the side of ditch furthest away from the track.

The principle in the crowning of embankments by making the top surface of two planes meet as a ridge in the center would undoubtedly be desirable, if it were practicable to maintain it in this form. For vari-

ous reasons, however, it is difficult to preserve such a section on embankments, and few lines find such susceptible of economical execution in actual practice. It is doubtful if many of the roads which show this feature on their standard plans even attempt to carry it out in actual practice, and if they do it soon becomes obliterated. Shoulders being exposed to the elements, settle faster than the center, and those parts of the embankments will therefore, sooner or later, practically slope themselves. In cuts, however, where hard material is encountered, it would, no doubt, be an aid to drainage if the roadbed were sloped with a slight pitch, true on either side from ends of tie, leaving a horizontal bed for the tie itself previous to ballasting. No definite angle for the slopes is here specified, as such can only be determined by the character of the respective materials and general local and climatic conditions. Neither are forms of sub-drainage, paving of ditches, nor methods of protection of slopes referred to in this report. Such items are also dependent upon local conditions, but their application will be dealt with in subsequent reports.

The features mentioned are simply those that pertain to the actual cross-section to be excavated or built.

#### IMPROVEMENT OF GRADES AND ALIGNMENT.

The question of economical grades and alignment is one that immediately concerns, in a more or less degree, every railway in the country, not only in regard to the improvement of existing features, but also in the determination of those for new lines.

Radical improvements in existing grades and alignment are generally only considered and undertaken when the traffic—present or immediately prospective—is of such volume as to make it imperative that the tonnage handled per train be largely increased, if such traffic is to be carried in the most profitable manner to the railway company.

The question, therefore, becomes, not so much getting the most good out of a certain amount of money to be spent in improvement, as the expenditure of sufficient money to obtain the good that is really required.

It is within the province of this report to outline some general principles, of which a thorough knowledge may assist in determining the limit where the money expended will yield the greatest return over the interest charges, and to aid in more easily deciding whether the amount of money allotted will be sufficient to obtain the results reasonably anticipated.

If the report apparently partakes of an elementary character, or lacks sufficient condensation, a justifiable plea for its present shape is made, viz., the importance of the subject, the request made by some members last year for information, and the desire of the Committee that every member (and especially those who may not be immediately familiar with the general subject) may have a thorough understanding of first principles from the beginning.

In regard to Tonnage Rating in connection with grade revision, it is evident that coöperation is necessary between the active head of the department in which the determining of improvements is vested and the superintendent of the motive power department; and it is obvious, that to make this coöperation effective in establishing the most economical profile, the common head of these two departments must be in sympathy with their views.

#### CONSIDERATIONS INVOLVED IN THE DETERMINATION OF GRADES AND ALIGNMENT.

All things being equal, the ideal line for a railway is a line straight between termini, and level throughout. With termini fixed at unequal elevations, the ideal line becomes a line straight and of uniform grade between termini. Again with traffic unequal in the two directions, the ideal line would be one not level but with grade uniform between termini, and so balanced for the unequal traffic that a locomotive would continually work at full capacity in either direction.

For obvious reasons, however, the ideal is seldom, if ever, feasible. Whenever any deviation from the ideal line seems desirable, such should not be made haphazard, but, in general, only so far as economy dictates. The elements entering into the consideration of the economy are: First—first cost; second—cost of operating; third—gross earnings.

Let  $i$  = interest on cost of construction

$c$  = cost of operating.

$e$  = gross earnings.

$p$  = profit.

then  $e - (i + c) = p$ .

This simple equation indicates that it is not enough that the interest on cost of construction and the cost of operating on a certain line A, shall together form a minimum as compared with an alternate line B. The reasonable earnings often form a controlling element. While  $(i + c)$  may be larger on line B, yet if  $e$  is also larger by a still greater amount, then B is the preferable line, as the formula shows. Furthermore, in a case where there is no difference in earnings on alternate lines, the requisite for economy then is, that the sum of  $i$  and  $c$  shall be a minimum. It is proper that  $i$  should be increased so far as is necessary, if only  $c$  be thereby decreased by a greater amount. Similarly  $c$  may be increased if thereby  $i$  shall be decreased by a greater amount.

It is evident that on a line where there are few trains, a moderate increase in the length and curvature of a line or an increase in its grades can probably increase  $c$  by only a small amount, so that a moderate saving in cost of construction will justify such a change. On the contrary, where the number of trains is large, the increased cost of operating a train or a ton on the inferior line will be multiplied many times, and the increase in  $c$  will be large, and a large saving in cost of construction will

be necessary to justify the adoption of the longer and more crooked line, or the line with heavy grades.

An increase in distance, curvature, or rise and fall adds somewhat to the cost of running each train, but has no effect on the number of trains for a given traffic. An increase, however, in the rate of the limiting grade or limiting curve increases the resistance to be overcome, making necessary a shorter train behind any given engine, and therefore a greater number of trains for a given traffic, and generally each of these must be hauled over an entire operating division.

It is obvious, therefore, that the differences in grade necessary to be considered are much more powerful in their effect upon the cost of operating than are changes in distance, while curvature and rise and fall are generally far less important, in view of the amounts in which they are involved. Curves, if used so as to have a limiting effect, are of primary importance also, but the better practice does not so use them at present.

#### LIMITING GRADE.

Considering the question of grade with reference to economy, the steepest actual grade to be operated by a single engine may be called the maximum grade. It is not, however, always the grade which limits the weight or length of train, for several reasons: First—The limiting grade is a virtual grade, and this may be different from the actual grade, due to a difference in velocity between the bottom and the top of the grade. Secondly—The steepest actual grade may be worked by a helper engine, and so fail to be the limiting grade on the basis of equivalent helper grades. Thirdly—Variations in the load over different parts of the division may cause some grade other than the steepest to become the real limiting grade, on the basis of equivalent grades for unequal traffic. This may be true not only as to grades in opposite directions, but also as to those in the same direction.

#### VIRTUAL GRADES.

Where a train passes over a grade at varying speeds, the virtual grade becomes a curved line. This results from the fact that train resistance and the power of the locomotive both vary with the speed. While this is true, virtual grades can better be understood if their consideration is first taken up on a basis of straight lines, such grade lines serving as measures of resistance. While train resistance is usually stated in the form of pounds per ton, it is frequently and conveniently expressed in the form of grade, and, as is well known, if the rate of grade in feet per 100 be multiplied by 20 the result is the equivalent number of pounds per ton.

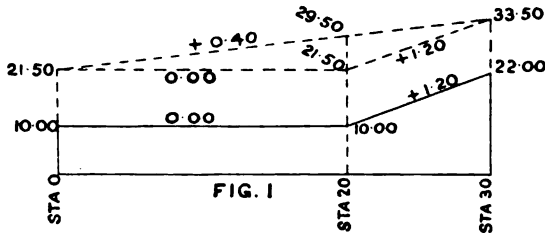
When a locomotive is hauling a load, the pull it exerts is frequently greater than that necessary to overcome the ordinary train resistances, even with curve and grade resistances added. The surplus pull, when there is any, acts on the train and accomplishes work whose equivalent is found in the increased energy of the train, and this may be measured by the increase in velocity. When the pull of the locomotive is less than what is necessary to overcome ordinary train resistances with curve and grade

resistance added, there is a deficit in the amount of work done compared with what is required; this deficit is practically the same as a retarding force which accomplishes work, whose equivalent is supplied by drawing on the energy stored in the train; the loss of energy is measured by the loss of velocity resulting. A train starting at 25 miles an hour at the bottom of a hill and passing the summit at 7 miles an hour will require less pull to haul it than if a uniform speed be maintained, as is well known.

Table 1, showing velocity heads, has been calculated anew by the well-known formula  $H = 0.0355 V^2$ . This value  $H$  we may call the "velocity head."

The actual profile is a matter of location and construction; the virtual profile introduces the element of operating; the latter depends in part on the actual profile, and in part upon the speeds at which certain points are passed. At any station or point on the actual profile where the speed is specified, if the velocity head due to that speed be added to the actual height, it will give a point to be known as the virtual height at this station. The lines joining a series of points marking the virtual heights thus found show the virtual grades, and the profile thus constructed may be called the virtual profile.

The inclination of the line of virtual grade at any point is the true measure of the resistance which the locomotive must overcome as grade resistance. It must overcome this in addition to the ordinary train resistance, as well as the curve resistance unless compensation for curvature has been used. A few examples may be of advantage.



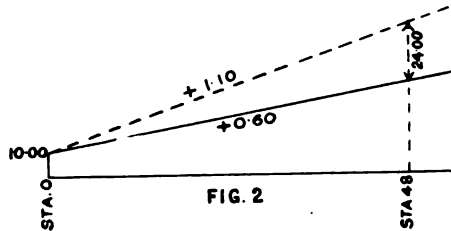
In Fig. 1 a train is to pass over the profile at a uniform speed of 18 miles per hour. The velocity head for 18 miles is 11.50. The virtual height at Sta. 0 will be 21.50, at Sta. 20, 21.50, and at Sta. 30, 33.50. The virtual grades will be straight and the same in rate as the actual grades. The engine need overcome from Sta. 0 to 20 nothing more than the ordinary train resistances (if on tangent). From 20 to 30 it must, in addition to these, overcome the resistance of a  $+1.20$  grade (24 lbs. per ton).

It may be required, however, that the engine shall exert a uniform pull, passing both Stations 0 and 30 at 18 miles per hour. Under this operating requirement, the average grade resistance to be overcome on the virtual grade will be  $\frac{33.50 - 21.50}{30} = +0.40$  (8 lbs. per ton). The train

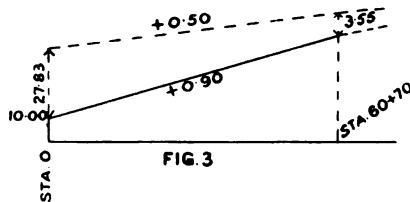
TABLE I.  
VELOCITY HEADS FOR VARIOUS SPEEDS.

Speed in Miles Per Hr.	VELOCITY HEADS IN FEET.									
	0	.1	.2	.3	.4	.5	.6	.7	.8	.9
0	0.00	0.00	0.00	0.00	0.01	0.01	0.01	0.02	0.02	0.03
1	0.04	0.04	0.05	0.06	0.07	0.08	0.09	0.10	0.12	0.13
2	0.14	0.16	0.17	0.19	0.20	0.22	0.24	0.26	0.28	0.30
3	0.32	0.34	0.36	0.39	0.41	0.43	0.46	0.49	0.51	0.54
4	0.57	0.60	0.63	0.66	0.69	0.72	0.75	0.78	0.82	0.85
5	0.89	0.92	0.96	1.00	1.04	1.07	1.11	1.15	1.19	1.24
6	1.28	1.32	1.36	1.41	1.45	1.50	1.55	1.59	1.64	1.69
7	1.74	1.79	1.84	1.89	1.94	2.00	2.06	2.10	2.16	2.22
8	2.27	2.33	2.39	2.45	2.50	2.56	2.63	2.69	2.75	2.81
9	2.88	2.94	3.00	3.07	3.14	3.20	3.27	3.34	3.41	3.48
10	3.55	3.62	3.69	3.77	3.84	3.91	3.99	4.06	4.14	4.22
11	4.30	4.37	4.45	4.53	4.61	4.69	4.78	4.86	4.94	5.03
12	5.11	5.20	5.28	5.37	5.46	5.55	5.64	5.73	5.82	5.91
13	6.00	6.09	6.19	6.28	6.37	6.47	6.57	6.66	6.76	6.86
14	6.96	7.06	7.16	7.26	7.36	7.46	7.57	7.67	7.78	7.88
15	7.99	8.09	8.20	8.31	8.42	8.53	8.64	8.75	8.86	8.97
16	9.09	9.20	9.32	9.43	9.55	9.66	9.78	9.89	10.02	10.14
17	10.26	10.38	10.50	10.62	10.75	10.87	11.00	11.12	11.25	11.37
18	11.50	11.63	11.76	11.89	12.02	12.15	12.28	12.41	12.55	12.68
19	12.92	12.95	13.09	13.22	13.36	13.50	13.64	13.78	13.92	14.06
20	14.20	14.34	14.49	14.63	14.77	14.92	15.06	15.21	15.36	15.51
21	15.66	15.80	15.95	16.11	16.26	16.41	16.56	16.72	16.87	17.03
22	17.18	17.34	17.50	17.65	17.81	17.97	18.13	18.29	18.45	18.62
23	18.78	18.94	19.11	19.27	19.44	19.60	19.77	19.94	20.11	20.28
24	20.45	20.62	20.79	20.96	21.14	21.31	21.48	21.66	21.83	22.01
25	22.19	22.37	22.54	22.72	22.90	23.08	23.27	23.45	23.63	23.81
26	24.00	24.18	24.37	24.55	24.74	24.93	25.12	25.31	25.50	25.69
27	25.88	26.07	26.26	26.46	26.65	26.85	27.04	27.24	27.44	27.63
28	27.83	28.03	28.23	28.43	28.63	28.83	29.04	29.24	29.45	29.65
29	29.86	30.06	30.27	30.48	30.68	30.89	31.10	31.31	31.53	31.74
30	31.96	32.16	32.38	32.59	32.81	33.02	33.24	33.46	33.68	33.90
31	34.12	34.34	34.56	34.78	35.00	35.22	35.45	35.67	35.90	36.13
32	36.35	36.58	36.81	37.04	37.27	37.50	37.73	37.96	38.19	38.43
33	38.66	38.89	39.13	39.37	39.60	39.84	40.08	40.32	40.56	40.80
34	41.04	41.28	41.52	41.77	42.01	42.25	42.50	42.75	42.99	43.24
35	43.49	43.74	43.99	44.24	44.49	44.74	44.99	45.24	45.50	45.75
36	46.01	46.26	46.52	46.78	47.04	47.29	47.55	47.81	48.08	48.34
37	48.60	48.86	49.13	49.39	49.66	49.92	50.19	50.46	50.72	50.99
38	51.26	51.53	51.80	52.07	52.35	52.62	52.89	53.17	53.44	53.72
39	54.00	54.27	54.55	54.83	55.11	55.39	55.67	55.95	56.23	56.52
40	56.80	57.08	57.37	57.66	57.94	58.23	58.52	58.81	59.09	59.38
41	59.68	59.97	60.26	60.55	60.85	61.14	61.43	61.73	62.03	62.32
42	62.62	62.92	63.22	63.52	63.82	64.12	64.42	64.73	65.03	65.33
43	65.64	65.95	66.25	66.56	66.87	67.17	67.48	67.79	68.10	68.42
44	68.73	69.04	69.35	69.67	69.98	70.30	70.62	70.93	71.25	71.57
45	71.89	72.21	72.53	72.85	73.17	73.49	73.82	74.14	74.47	74.79
46	75.12	75.44	75.77	76.10	76.43	76.76	77.09	77.42	77.75	78.09
47	78.42	78.75	79.09	79.42	79.76	80.10	80.43	80.77	81.11	81.45
48	81.79	82.13	82.48	82.82	83.16	83.50	83.85	84.19	84.54	84.89
49	85.24	85.58	85.93	86.28	86.63	86.98	87.34	87.69	88.04	88.40
50	88.75	89.11	89.46	89.82	90.18	90.53	90.89	91.25	91.61	91.97
51	92.34	92.70	93.06	93.42	93.79	94.15	94.52	94.89	95.26	95.62
52	96.99	97.36	97.73	98.10	98.47	98.85	99.22	99.59	99.97	100.34
53	99.72	100.10	100.47	100.85	101.23	101.61	101.99	102.37	102.75	103.13
54	103.52	103.90	104.29	104.67	105.06	105.44	105.83	106.22	106.61	107.00
55	107.39	107.78	108.17	108.56	108.96	109.35	109.74	110.14	110.53	110.93
56	111.33	111.73	112.12	112.52	112.92	113.32	113.73	114.13	114.53	114.94
57	115.34	115.74	116.15	116.56	116.96	117.37	117.78	118.19	118.60	119.01
58	119.42	119.83	120.25	120.66	121.07	121.49	121.91	122.32	122.74	123.16
59	123.58	123.99	124.41	124.84	125.26	125.68	126.10	126.53	126.95	127.37
60	127.80	128.23	128.65	129.08	129.51	129.94	130.37	130.80	131.23	131.66

will gain in speed from Sta. 0 to 20, because the engine exerts on a level the pull necessary for a  $+0.40$  grade. From Sta. 20 to 30, the pull suitable for a  $+0.40$  grade is unequal to overcoming the actual  $+1.20$  grade; the energy of the train is drawn upon, the speed steadily decreases and finally becomes 18 miles at Sta. 30. Assuming the virtual grade to be a straight line, the elevation of the virtual above the actual grade at Sta. 20 will be  $29.50 - 10.00 = 19.50$  ft., which corresponds to a speed of about  $23\frac{1}{8}$  miles, and this is the speed the train would have at Sta. 20. Strictly, the virtual grade should be a curved line, due to train resistance varying, and the speed would then be slightly different from that given.



Again in Fig. 2, we may know (from experience or experiment, or from computations) that the engine in starting from rest and acquiring a speed of 26 miles per hour can exert on the average between speeds of 0 and 26 miles per hour a pull just sufficient to overcome a grade of  $+1.10$ , on a tangent, in addition to ordinary train resistance. How far must the train run before the speed of 26 miles shall be secured? Evidently to the station where the distance between the  $+1.10$  and the  $+0.60$  grades will be 24.00 feet (the velocity head for 26 miles) or  $\frac{24.00}{1.10 - 0.60} = \text{Station } 48$ .



Similarly in Fig. 3. An engine can haul its train up a grade of  $+0.50$  when the speed varies from 28 to 10 miles per hour; it is expected to pass Sta. 0 at 28 miles per hour. At what station on this profile will the speed (gradually reducing) become 10 miles per hour? The velocity head at Sta. 0 (due to 28 miles) will be 27.83, and for 10 miles 3.55. The speed of 10 miles will be reached when the  $+0.50$  and the  $+0.90$  grades are 3.55 ft. apart or at a distance  $\frac{27.83 - 3.55}{0.90 - 0.50}$  or at Sta.  $60 + 70$ . If it is thought necessary to maintain further a speed of at least 10 miles per hour

to avoid risk of stopping, it will follow that the grade beyond Sta. 60 + 70 cannot be as high as +0.90, but must be reduced to that grade at which the engine can haul its train at 10 miles per hour. This will really be somewhat greater than +0.50, since the engine at the uniform speed of 10 miles can pull its train up a steeper grade than the average grade for speeds varying from 28 to 10 miles.

A momentum grade may be defined as a grade operated in such a way that surplus energy stored in a train is drawn upon to allow the train to be hauled up this grade, with less resistance to be overcome by the pull of the engine, than would be necessary if uniform speed were maintained. The common case of momentum grades is that where the train passes the foot of a steep grade at comparatively high speed, and is allowed to pass the summit at low speed. The practical problem for the engineer engaged in location or construction is generally to determine either (a) how far a steep actual grade can be continued and yet allow a required virtual grade to be maintained, (as considered with Fig. 3) or, where an actual grade is under consideration, to determine (b) what the virtual grade will really be under prescribed conditions of operating (following the method used in Fig. 1), and also in this connection often to find (c) the speed which it is possible to acquire at the foot of a momentum grade (as in Fig. 1, at Sta. 20).

Modern railroad practice has substantially established the fact that momentum grades have their uses and are frequently of great value, but there are definite and well-known important objections to their indiscriminate use, and that they should be adopted as a matter of course ordinarily or wherever opportunity offers, especially in original location, may be seriously questioned.

The advantage of momentum grades is most apparent on short grades, or just where there is the best opportunity generally to reduce the actual grade. It should not be lost sight of that any grade lower than the limiting grade may at any time have value, due to the fact that many trains do not carry the same load throughout an entire division, but take on or set off cars at stations, with the result that any grade lower than the apparent limiting grade of the division may become temporarily, or even permanently, the real limiting grade, due to the greater loads hauled over it, and the lower grade may thus have the effect of increasing the capacity of the entire division. In revision of line, conditions of traffic and of operating are more definitely settled, and the use of momentum grades can be more intelligently made. It is often a choice between a momentum grade and the alternative of a lower train load over a division, if the grade in question is the real limiting grade of the division.

The proper procedure is for the engineer to note evidence bearing upon the matter from other similar features, to estimate in each case the advantages and disadvantages of the momentum grade, to take into account cost of construction and operating and to consider safety and convenience, and then, with these bearings in view, exercise his best judgment.

The principle of virtual grades finds an interesting application in connection with regular stopping points, such as stations on a railway where

nearly all trains are local. By reference to Fig. 4, it is clear that advantage results from raising the elevation of the track at such a point. The virtual grade being substantially uniform, the speed is decreased for trains approaching the station from either direction; in starting from the station the grade is also more favorable than the uniform grade, and any desired acceleration is acquired sooner.

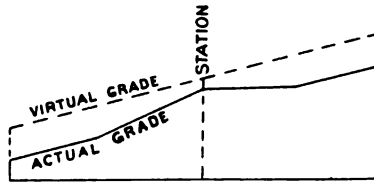


FIG 4

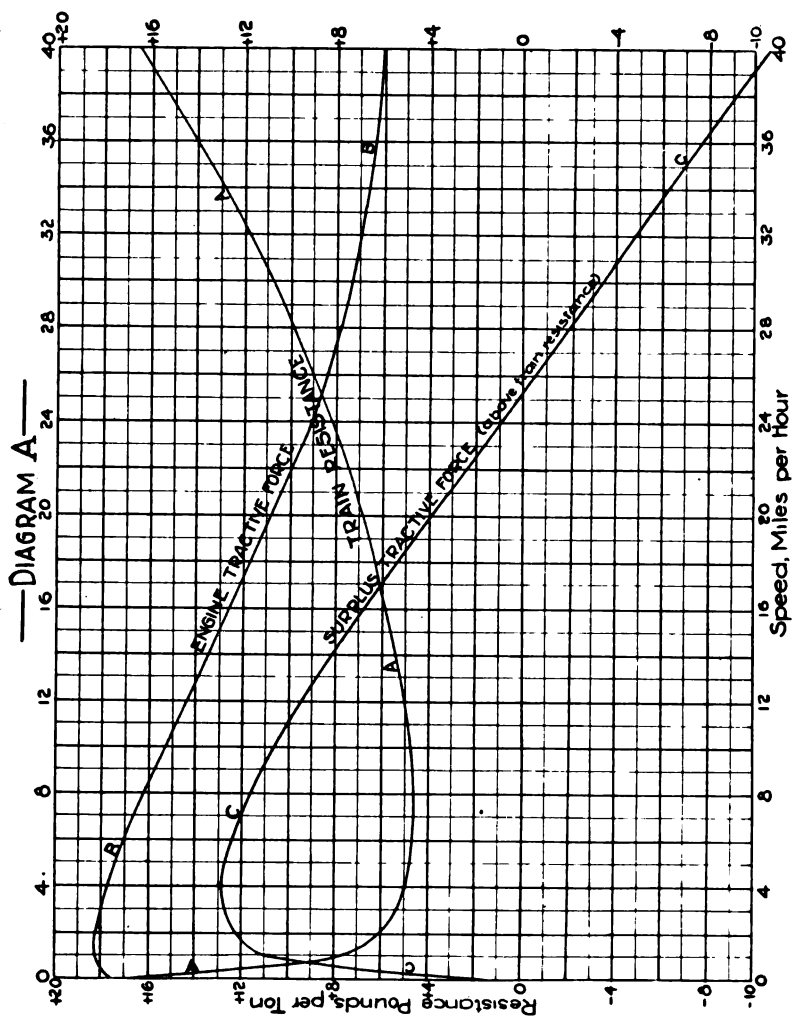
At stations where many through trains pass, the only disadvantage would be a diminution of speed in passing the station, which is not altogether disadvantageous on the score of safety.

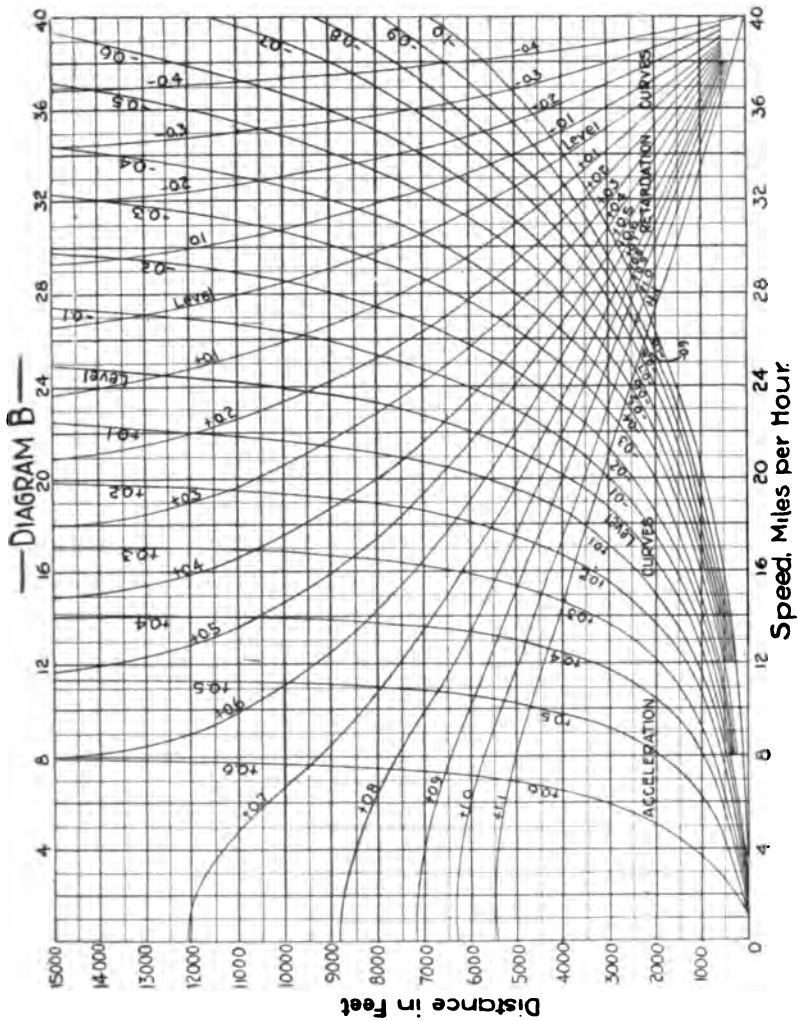
The subject has thus far been treated on the assumption that a straight line represents the grade up which the engine can haul its train. This is true only when the speed continues uniform. With higher speeds the tractive power of the engine decreases, and in addition, the train resistance increases. The grade up which the engine can haul a given train is less at high speeds than at low speeds, and when the engine starts at a high speed and steadily decreases its speed, the line up which it can haul its train will be curved with the grade flatter at the beginning and steeper as the speed decreases. It is difficult and probably impracticable to directly apply this curved line to an actual profile. It may be possible to substitute for the curved line some straight line whose effect will make it a substantial equivalent for the curved line, but a simple solution in that direction is not an easy matter.

A somewhat different method of solution which is interesting, as well as substantially correct, is in use on the Canadian Pacific Railway in the form of a diagram by which, in the case of a given engine and train, one can find for each grade the speed the train may acquire (or lose) in given distance, or vice versa the distance necessary to acquire (or to lose) any given speed. The diagrams A and B may be explained as follows:

In Diagram A the curved line A A A shows train resistance in lbs. per ton, for various speeds (being Wellington's curve). The curved line B B B shows the tractive force of the locomotive, reduced to lbs. per ton of train. The train in this case weighs 1600 tons without the engine and 1730 tons with the engine. The engine is rated as capable of hauling this train up a grade of 0.60 at a uniform speed of 7 miles per hour. This particular type of engine was selected as the most unfavorable in use.

The curved line C C C shows the excess of engine tractive force over train resistance for the above engine and train. The ordinate (above 0 line) to C C C at any speed = the difference in ordinates between lines





A A A and B B B. Where the train resistance is in excess of the tractive force of the engine, the line C C C lies below the o line of the diagram.

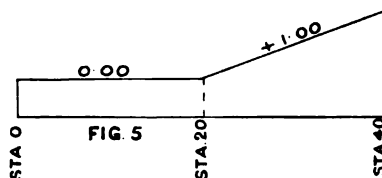
Diagram B is plotted from a series of results, the computation of which may easily be understood by reference to Table 2. This table is in simple form, and hardly needs a detailed explanation of method of computation.

TABLE II.

Speed Miles Per Hour.	Vel. Head for Same.	Difference in Vel. Heads.	Surplus Tractive Force of Engine.	Same In Grade.	Level.		- 0.5 Grade.		+0.7 Grade
					Distance for 1 Mile Increase.	Total Dis- tance.	Distance for 1 Mile Increase.	Total Dis- tance.	Distance for 1 Mile Increase.
0	0.								
1	0.04	0.04	8.0	0.40	0.1	0.1	0.0	0.0	- 0.1
2	0.14	0.10	11.8	0.59	0.2	0.2	0.1	0.1	- 0.9
3	0.32	0.18	12.5	0.63	0.3	0.6	0.2	0.3	- 2.6
4	0.57	0.25	12.8	0.64	0.4	1.0	0.2	0.5	- 4.2
5	0.89	0.32	12.8	0.64	0.5	1.5	0.3	0.8	- 5.3
6	1.28	0.39	12.5	0.63	0.6	2.1	0.3	1.1	- 5.6
7	1.74	0.46	12.2	0.61	0.8	2.9	0.4	1.5	- 5.1
8	2.27	0.53	11.8	0.59	0.9	3.8	0.5	2.0	- 4.8
9	2.88	0.61	11.3	0.57	1.1	4.9	0.6	2.6	- 4.7
10 etc.	3.55	0.67	10.8	0.54	1.2	6.1	0.6	3.2	- 4.2

For each line representing grades, a complete table of computations is made for the various speeds and from this table the acceleration lines of Diagram B are plotted.

The retardation line for 0.7 might be plotted below the base line, and the same is true also of the lines for 0.8 grade, 0.9, etc. The retardation lines for grades less than 0.6 will never pass through o, since they become retardation lines only at high speeds. The retardation lines are therefore plotted from speed 40 as a starting point, and the distance necessary for a change of speed from 40 to 39, or the distance necessary to reduce speed from 40 to 39 is therefore plotted at 39 and similarly total distances necessary to reduce speed from 40 to 38, to 37, etc., are plotted at the appropriate points. Table III shows all distances for changes of speed from 0 to 40.



The total distances here are computed from 40 as a starting point and the retardation lines are plotted accordingly.

A few examples will illustrate the use of Diagram B. In Fig. 5 the train is assumed to start from Sta. 0 from rest.

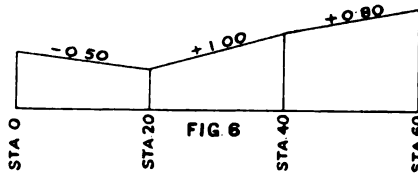
What speed will this train acquire at Sta. 20? Follow the level line until it intersects 2000 feet. This is at speed  $16\frac{1}{2}$ .

TABLE III.

Speed Miles per hour.	Vel. Head for same.	Difference in Vel. Heads.	Surplus Tractive Force of Engine.	Same in Grade.	+ 0.7 Grade.	+ 0.7 Grade.	
					E - 0.70	Distance for 1 Mile Inc.	Total Distance.
40	56.80						
39	54.00	2.80	-10.8	-0.52	-1.22	- 2.3	- 2.3
38	51.28	2.74	- 9.5	-0.48	-1.18	- 2.8	- 4.6
37	48.60	2.66	- 8.8	-0.44	-1.14	- 2.8	- 6.9
36	46.01	2.59	- 8.1	-0.41	-1.11	- 2.8	- 9.2
35	43.49	2.52	- 7.4	-0.37	-1.07	- 2.4	-11.6
34	41.04	2.45	- 6.7	-0.34	-1.04	- 2.4	-14.0
33	38.66	2.38	- 6.0	-0.30	-1.00	- 2.4	-16.4
32	36.35	2.31	- 5.2	-0.26	-0.96	- 2.4	-18.8
31	34.12	2.23	- 4.6	-0.23	-0.93	- 2.4	-21.2
30	31.95	2.17	- 3.8	-0.19	-0.89	- 2.4	-23.6
etc.							

How far on the + 1.00 grade will this train run before its speed will be reduced to 7 miles per hour? Find on retardation line + 1.00 the difference between the ordinates at speed  $16\frac{1}{2}$  and at speed 7. At  $16\frac{1}{2}$  speed the ordinate or distance = 4150; at 7 distance = 5850. The answer then is  $5850 - 4150 = 1700$  feet. Beyond this the grade must be reduced to a + 0.6 grade to allow this particular engine (or type) to haul its 1600 ton train at 7 miles per hour.

In Fig. 6 the train passes Sta. 0 at 25 miles per hour to a - 0.50 grade. What will be the speed at Sta. 20? On a grade of - 0.50 to acquire from rest the speed of 25 miles the train would have to run about 2800 feet. The train is therefore in the condition of a train which has run down a - 0.50 grade for 2800 feet. The speed at bottom of grade will be, therefore, that due to this 2800 feet + 2000 feet of actual grade (Sta. 0 to Sta. 20) or 4800. This is a speed of about 29.5 miles as shown by the point where the - 0.50 line cuts the diagram at 4800 distance. What will be



the speed at Sta. 40 on a + 1.00 grade? The distance on a + 1.00 retardation line at 29.5 speed is 1850; the speed then will be that shown by the intersection of + 1.00 grade with  $1850 + 2000 = 3850$ , or at 18.2 miles. What speed at Sta. 60? Speed 18.2, grade + 0.80 gives 4850. Add 2000 ft. to Sta. 60 = 6850 grade + 0.80 and distance 6850 gives 10.3 speed.

In like manner the speeds and distances can be traced over any profile. Whenever special requirements as to speed are made, as at stopping places,

a fresh start will be made. It may further be considered good practice to depend upon a low speed of 7 miles or 10 miles at important summits or tops of descending grades, even though a somewhat higher speed may appear possible in working with this diagram. Again at low points or sags, a maximum speed of 25 miles or of 30 miles may be specified by the regulations of the railway.

Any theoretical determination which depends upon both a curve for tractive force of engine and a curve (or straight line) of train resistance, must be subject to the criticism that even if the tractive power of the engine is reliable, yet on any particular railway the train resistance is likely to be different (often materially so) from that given by any of the well-known formulas or curves.

The series of curves shown in *Engineering News*, Oct. 31, 1901, is even more conclusive evidence on this point. Nearly all of the lines shown in that diagram represent results of actual experiment on some railway at some time, and have extraordinary range. The work of finding the tractive power of an engine at varying speeds is also carried on at some disadvantage and inconvenience. There are two sources of possible error therefore in determining the surplus tractive force available for grade or for increased speed.

There would apparently be an advantage in point of simplicity in determining this surplus tractive force directly if a convenient means could be found for doing this. Fortunately it can be done by the simple expedient of critically observing velocities continuously during a run, in which the locomotive is handled with the object of securing reasonable uniformity and also thorough effectiveness in tractive force. The velocities must be properly connected with the actual profile of the road. Furthermore, for this purpose, the speeds must be observed with a degree of precision definitely greater than is commonly secured. In fact it is probable that some special form of speed recorder would be needed for this purpose. The ordinary speed recorders in use would not serve the purpose.

The records of distances and speeds made in such a test would give directly a considerable number of figures necessary for Table II. Dynamometer records would not be essential. They would be very desirable if easily obtained, as sudden and irregular changes in draw-bar pull would thereby be detected and possibly results in certain cases might be thrown out as accidental and not typical; the tests, however, would be in all respects more complete if dynamometer readings were made.

The replies made to the inquiry of this Committee in relation to methods of Tonnage Rating seem to indicate that the practical tests are seldom carried out with the addition of speed records. It reasonably follows that even when Chief Engineers and Engineers of Maintenance of Way are opposed to the use of momentum grades, yet in practically rating the engines, it is probable that in many cases a hill is actually climbed by using a higher speed at bottom and a lower speed at top. It is in any case desirable to know just how the steep grades are overcome, and careful speed records are essential for this purpose. On some railways careful

tests have been made both upon train resistance and upon the tractive power of the locomotive, and tests also as to speed in practical running test, and in such cases the ratings deduced have, in certain cases, at least agreed well with the practical road tests, as might be expected.

#### CURVATURE.

In computing from diagrams the speed a train will acquire at the foot of a grade where there are curves, an allowance must be made for the curves decreasing the grade. If curves are not compensated, this grade adjustment will be the total curve height allowance divided by the distance. If compensated, the grade adjustment will be twice as much, since the train will encounter both the curve and the flattening of grade also.

From the result of the Committee's inquiries it would seem that the practice in this country at present favors compensation proportional to degree of curve, and 0.04 per degree represents average practice. The observation of the effect of compensation however seems on the whole not to have been critical enough to determine, definitely, whether or not it should be proportional to the degree of curve, and experiment and critical observation is further needed; the effect of curves as shown on a speed recorder capable of recording slight changes in speed is suggested as a desirable method of experimenting.

#### PRACTICAL WORK OF GRADE REDUCTION AND CURVE IMPROVEMENT.

In the practical work of grade reduction, after the type of engine to be used has been settled, the rates of grade permissible decided upon, and the extent to which momentum and equivalent grades may be used has been determined, the location of the new work is the important question. This subject resolves itself naturally into three classes:—

First—A new location far enough away from the existing line, to be treated as a separate line, and built according to the usual methods of construction independent of the old line.

Second—Raising or lowering the existing line on the original right-of-way and alignment.

Third—A combination of the first two classes mentioned, in each particular section of work under construction.

The third class is by far the most usual, and generally the most economical way, for the reason that it takes advantage of all available existing work, and only takes to a new alignment where required.

The experience of the engineers of a prominent line on which a large amount of grade reduction and change in alignment has been done, has shown them, that in grade improvements made for substantial distances, it is better to build an entirely new line, and not interfere with the existing traffic in any way. That is, they appear to have succeeded in doing so for less money than by keeping the traffic moving over the existing line.

A question of this nature, however, together with the extent to which an existing line may be disturbed, and traffic impeded, must of course be decided for each individual case; the governing elements being the density of traffic or frequency of trains, and the amount of saving reasonably expected from an intelligent comparison of the probable cost of each.

The various items to be taken into account in a tabulated comparison of the cost of the maintenance and operation of a new line, with that of the old, as well as the method of pro-rating them, are so well understood that it is unnecessary at present to enter into details bearing upon them.

In the practical work of almost all grade improvements, the steam shovel is usually the most important factor, and the Committee endeavored to bring out for this report such facts as might be of use to those contemplating such work. To this end a series of practical questions were framed and sent to the members of the Association in the form of a circular, and a brief digest of the answers received follows.

#### CHARACTER OF SHOVEL.

Shovels varying in weight from 35 tons to 80 tons, and in dipper capacity,  $1\frac{1}{2}$  to 3 cubic yards, were respectively mentioned as desirable by various members, but the majority of the replies embraced opinions that a shovel weighing 65 tons, with a  $2\frac{1}{2}$  cubic yard dipper, and at least 14 feet clear height of dipper above rail was the most serviceable shovel for general railway work.

#### FORM OF SHOVEL TRACK.

Lengths of 4 feet to 10 feet were mentioned as being used, but over 50 per cent of the replies advocate a length of 6 feet sections for shovel track, fastened together with tie bars, and the rails joined with short splices, with one or two bolts, each.

Many replies stated that they used keys in place of bolts, to fasten the short splices. A form of track mentioned has wrought iron chairs on the joint ties, into which the rail ends fit. No splices nor tie bars are used with this particular track, and it has the advantage, that a single piece of rail, say 6 feet long, is the heaviest thing to handle in moving up.

Another form had the sections with tie bars resting on stringers 6"x12", and the stringers resting on ties, and blocking as required.

#### GAUGE OF SHOVEL TRACK.

Standard gauge was recommended almost unanimously, generally because of ease of movement from place to place, and the ability to make use of tracks and sidings already laid. Two answers, however, recommended the 3 feet gauge, for the reason that cars were more easily handled on the dumps.

#### FORM OF CARS.

There is considerable diversity of opinion in regard to the best form of cars, but it is in line with the general answers received that Rodger or Goodwin ballast cars without plows are used for trestle filling where

the material is such that it will readily flow through such cars; and that Haskell & Barker cars are used with a plow and Lidgerwood unloader wherever there are no boulders or frozen clay to be dealt with, and that where boulders and frozen clay are met with, that flat cars with side stakes are used. Counter or side-dump ballast cars or swinging sides of from 14 to 20 yards' capacity, for use with plows, seem about equal in favor. Only a few advocate the use of small 5 to 7 yards dump cars. All the replies received favor the use of aprons with all cars used with plows and cables.

#### UNLOADING CABLES.

Unloading with plows and cables seems to be very satisfactory to practically all who answered our inquiries, but a majority considered that the use of an unloader, and not the locomotive, was required, in order to secure the most economical working.

The length given of cable proper to be used varied from 400 feet to 2000 feet. General opinion seemed to be, that for use with the locomotive alone, 20 cars were all it was economical to handle at one time, but that with an unloader, 30, 35 or 40 cars, or whatever the locomotive could pull, were allowable in a train. Those favoring long trains, stipulated that the train length should be shortened on a crooked road, and all advocated the use of snatch blocks on curves.

#### SPREADERS.

About 70 per cent of the members who made reply, use some form of spreader or bank leveller, but there is great diversity in the kinds used. There are principally two classes of such spreaders.

First—Those in which the wings open downward and outward, with hinges horizontal, and are handled either by a windlass or air pressure.

Second—Those in which the wings fold against the sides of the cars, with a vertical hinge near the front of the car. In this class the wings may be adjusted for height.

Some of the second named class are reported very effective, but are a little slow for getting out of the way of trains. Those of the first-named class, when operated by air from the locomotive seem the best, because of the ease with which they can be handled.

For quick work in grade reduction, it is essential that they have wings on both sides.

#### NEW EMBANKMENT.

The Committee have endeavored to ascertain between what limits various methods of making embankments were economical, such as raising the track on the filling material, the use of a central core put up by team work and widened with the shovel cars, the use of filling trestle, etc.

In raising track on embankments, it seems to be good practice to raise only about nine inches at a time, if the traffic is at all heavy; and even with very light traffic, not more than twelve inches. This method can, of course,

be used to any height, but it ceases to be economical when a central core can be put up by team work, and all widening be done by shovel, without handling track so often.

Where banks are to be over 15 feet in height, the temporary filling trestle seems to be considered to give the best results.

Instances are quoted in some of the replies where banks forty feet high, and built several years ago, are giving excellent results from the central filling trestle method. These banks were built of new material in the fall and winter, and put into service in the spring. They have settled about four feet in all, but the settlement has been uniform, and no tendency to slide has developed, although the material is mostly clay. The drop has no doubt been of considerable service in solidifying the mass, and it is thought that the piles of the temporary trestle work have also a good effect in steadying it.

Some of our members recommended the putting in of the base of embankments with teams, as this would obtain the necessary ditches.

An ingenious method has recently been used on some very high fills. It consists of supporting a truss span, one end on the bank, and one end on a movable tower, and using a short train of cars to dump from the span and make the fill. The span is moved ahead as may be required.

#### SHRINKAGE.

There can, of course, be no uniform rule laid down for allowance for shrinkage, as the required amount varies so greatly with the material. Three to ten per cent is a fair range, and it is recommended that allowance for shrinkage be made in width, as well as in height of banks.

#### SHOVEL RECORDS.

There seems to be no uniformity in the method of keeping shovel records, but the Committee have in view an analysis of those actually in use, and hope at some future time to recommend a standard form.

Respectfully submitted,

W. McNAB, Asst. Eng. G. T. Ry. Sys., Montreal, Can., *Chairman*;  
 C. DOUGHERTY, Roadmaster I. C. R. R., Chicago, *Vice-Chairman*;  
 C. FRANK ALLEN, Prof. of R. R. Eng. Mass. Inst. of Tech., Boston;  
 H. BALDWIN, E. M.-of-W. C., C. & St. L. Ry., Indianapolis, Ind.;  
 R. C. BARNARD, E. M. of W. Penna. Lines W., Cincinnati, O.;  
 W. D. PENCE, Prof. of Civil Eng. Purdue Univ., Lafayette, Ind.;  
 H. C. PHILLIPS, Asst. Supt. A., T. & S. F. Ry., Fort Madison, Ia.;  
 H. J. SLIFER, Supt. C. & N.-W. Ry., Boone, Ia.;  
 J. T. WILSON, C. E., P., C. & W. R. R., Wheeling, W. Va.

*Committee.*

President Kittredge:—Inasmuch as the reports of the various committees have been printed and distributed some time in advance of this meeting, I hardly think it necessary for the report to

be read in its entirety. I will, however, call on the chairman of the Committee to make any remarks or explanations or suggestions in regard to the report which he may feel are needed.

Mr. W. McNab (Grand Trunk) :—Mr. Chairman, in regard to this report of the Committee on Roadway, which I have the honor to formally present, I do not think it is particularly necessary for me to make any special remarks, unless such remarks be by way of a few words of apology. It is a matter of regret to me, as well as to my colleagues, that this report did not reach the Secretary earlier, so that it might have been in your hands in sufficient time before the convention opened to have given you an opportunity at least to examine it. But, as you know, it is by no means an easy matter to settle upon final details before presenting the result for discussion. Anyone who has taken an active part in committee work will thoroughly understand that, and the difficulty is all the greater by reason of the residences of the members of the Committee being widely separate; that is, in regard to convenience of the members meeting to discuss the subjects submitted to them. In such cases a great deal of the work has to be done by correspondence, which naturally becomes quite voluminous. However, the Committee have met and have given the subject-matter herein contained careful consideration, and, it is hoped, in a manner that may prove of benefit to the Association. If it is not in as much detail as some might have wished for, it is hoped that whatever it is apparently deficient in in that respect may be reasonably inferred. It will be noticed that the report has been prepared in three main divisions: First, "Cross-sections of Roadway;" second, "Improvements of Grades and Alignment;" third, "Practical Work of Grade Reduction and Curve Improvement."

In order that the discussion be not scattered, I would suggest that it take place on these divisions in order. Further, Mr. Chairman, I would remark that there are only about eighteen hours in which to transact the whole of the business of the convention, and this Committee cannot reasonably expect a monopoly of the time; it would therefore be well in regard to the discussion that it be prompt and to the point. If anyone present desires to discuss the report, and is not fully prepared to do so at the present time, by reason of the late hour at which it reached you, it may

be stated that it will be entirely in order to transmit such discussion by mail, and it will be incorporated in the printed proceedings of the convention. I do not think it is necessary to add anything further, but will simply say that the report is now open for discussion.

President Kittredge:—Printed copies of all the reports can be had in the lobby, and any person who has not a copy of this report can get one by coming to this desk. This report has been printed and is in your hands, and it will be in order for someone to make a motion to dispose of it, either by accepting the report or criticising it, and then it will come before the members formally for discussion.

Mr. McNab:—Through an oversight, the Committee failed to incorporate with the report when it was being printed a recommendation to the Association. I do not know whether it is in order for me to supplement the report by presenting that recommendation at this time.

President Kittredge:—I think it is in order to present the recommendations at this time.

Mr. McNab:—The report should have contained the following recommendations:

“Resolved, That this Association approves of the opinions of this Committee that on first-class roads of standard gauge, with constant and heavy traffic, a minimum width of 20 feet at subgrade is good practice.

“That when finances will warrant it, and where the excavation can be used in embankments within reasonable haul, uniformity in width of subgrade in cuts and in embankments is proper.

“Local circumstances should invariably be taken into account in determining the angle of repose of any given material to be dealt with, and slopes should be varied to suit the character of the respective materials.”

President Kittredge:—For the purposes of discussion, I will mark the three paragraphs of the resolution just read by Mr. McNab as 1, 2, and 3. No. 1 is that “the Association approves of the opinions of this Committee that for first-class roads of standard gauge, with constant and heavy traffic, a minimum width of 20 feet at subgrade is good practice.” No. 2 is that “when the finances will warrant it, and where the excavation can be used in embankments within reasonable haul, uniformity in width of subgrade in cuts and embankments is proper.” No. 3 is that “local circumstances should invariably be taken into ac-

count in determining the angle of repose of any given material to be dealt with, and slopes should be varied to suit the character of the respective materials." This should be considered as part of the report as submitted. I now await a motion as to what to do with the report.

Mr. H. G. Prout (Railroad Gazette) :—I move that the report be accepted and resolution No. 1 adopted.

President Kittredge :—I think that the motion has been made in a proper way. I believe it would be proper to accept and act upon each resolution separately.

Mr. W. C. Cushing (Pennsylvania Lines) :—I think there is some misunderstanding about these reports. If they were put in the hands of the other members at the same time they were put in my hands, the members do not know very much about what is in this report. I certainly do not, because I did not see it until I came to the meeting room a short time ago. With very few exceptions the reports were all late. I think perhaps the lack of discussion so far on this topic is due to the members not being familiar with the report. The first resolution of the Committee is quite clear and concise and I would imagine there should be no trouble about voting on that. I think, however, in general, that most of the members are unacquainted with the real gist of the report.

President Kittredge :—As has been stated, there have been a great many delays that have been disappointments to the Board of Direction and to some of the committees. Some of the reports were received very late, and others took a longer time in printing than was expected. This report happens to be one of those that was not received very early, having reached us in the early part of March.

Mr. McNab :—Regarding Mr. Cushing's remarks, the first division of the report to which this resolution refers is short and concise, and there should therefore be no difficulty about taking it under consideration and discussing it at the present moment if necessary. The part of the report dealing with this matter does not embrace more than a page and a half and is paragraphed in such a way that it can be easily understood.

President Kittredge :—In view of Mr. Cushing's remarks, it might be well to discuss the report by paragraphs. I think that could be done under the motion that is before the house.

Mr. Cushing :—I make the suggestion that those reports which have been placed in the hands of the members in advance of the meeting be taken up first, and it may be that during the course of the meeting the members will have an opportunity to look at these reports, if they have not done so previously.

President Kittredge :—That plan had been intended, but we had to call on this Committee a little earlier than expected because the chairman of the committee that was to be called first is absent. I think it would be quite unwise to carry on the discussion of the reports in the absence of the chairman of the committee, or someone to represent him. We hope the presence of all chairmen later; but the chairmen of the committees whose reports we expected to first present were not present when we opened the session.

Mr. Hadley Baldwin (Cleveland, Cincinnati, Chicago & St. Louis) :—I presume there is no objection to accepting the report of the Committee, since the resolutions offered apply only to the question of cross-sections. I suggest that that part of the report be read, and then the resolutions can probably be intelligently discussed.

(The Secretary read the first section of the report.)

President Kittredge :—Is there any further discussion?

Mr. J. A. Atwood (Pittsburg & Lake Erie) :—I think the roadbed suggested for embankment is a proper one. Twenty feet is the minimum that should be used. It is the one we have been accustomed to for years, and I think the resolution is a proper one to be adopted.

Mr. A. Torrey (Michigan Central) :—As I understand the text of the recommendation of the Committee, the minimum width of the roadway and the embankment, irrespective of the height, is to be 20 feet. We have always found it advisable to make the width of the embankment in high fills greater than in the case of low fills, in the expectation that the embankment would settle more where it was deeper, and that the additional width in the first construction will furnish a shoulder more or less solid on which to raise the track in the future. I think it is worthy of consideration whether such construction is something to recommend. Our practice on the Michigan Central is to widen the base of the embankment one foot additional to what the uniform

width would make it—one foot for every five feet in the height of the embankment. We generally build a trifle above grade, but always wide, and picking up the track later involves less material.

President Kittredge:—Would you offer any suggestion or amendment to the motion?

Mr. Torrey:—I thought I would bring out that point.

Mr. McNab:—In regard to Mr. Torrey's remarks concerning the practical work of construction, which are much appreciated, the Committee made a recommendation that allowance for shrinkage, which I presume is what Mr. Torrey refers to, be made according to circumstances, in both height and width; and further, when 20 feet is spoken of, a maintained width is what is meant. It is referred to on the last page of the report. The Committee will slightly amend its resolution by adding the word "permanent," so that it will read as follows: "This Association approves of the opinions of this Committee that on first-class roads of standard gauge, with constant and heavy traffic, a minimum permanent width of twenty feet at subgrade is good practice."

President Kittredge:—If Mr. Prout and his second will accept that amendment, we will take a vote on the resolution as amended.

(Resolution No. 1 was adopted.)

President Kittredge:—Gentlemen, what is your pleasure in regard to resolution No. 2, which reads as follows: "That when finances will warrant it, and where the excavation can be used in embankments within reasonable haul, uniformity in width of subgrade in cuts and embankments is proper." Perhaps it would be consistent to introduce into that resolution the word "permanent," in order to make the resolution uniform with the one just adopted.

Mr. McNab:—For the purpose of making the resolution uniform it will not do any harm. It is practically understood; but it might be as well to insert it.

President Kittredge:—I think there is a little difference in leaving the width unqualified and making it "permanent width." What shall be done with the second resolution?

Mr. Prout:—I move the resolution be adopted.

(Seconded by Mr. Raymer.)

Mr. Cushing:—I do not like the wording of the resolution as well as I do the paragraph from which it is taken in the report proper, which further supplements the statement by saying, "outside of which sufficient room must be allowed for side ditches." There is more trouble, as a general rule, in the cuttings than with the embankments, the drainage feature of which is the controlling one. Consequently, any narrowing up of the cuts is almost certain in all cases to be detrimental. I think, therefore, the provision in regard to the ditches being commonly outside of what may be considered as the ditch line, or sod line, or whatever line it may be called, is eminently proper, and one of which I am very much in favor. I do not like the paragraph in the report in which it advocates the narrowing up of the cutting to meet cases of economy. I think it is false economy. It ultimately results in greater expenditure for maintenance. I, therefore, am much in favor of the resolution standing as it does, with the addition of the other sentence in the report—"outside of which sufficient room must be allowed for side ditches." I would offer that as an amendment to the motion.

Mr. McNab:—As far as the Committee is concerned, they accept the amendment, because it was an understanding they had, and although it has not been actually inserted in our recommendation, it is emphasized in the report itself.

Mr. A. R. Raymer (Pittsburg & Lake Erie):—As the method outlined by Mr. Cushing is the method followed by the Pittsburg & Lake Erie, I had that in mind in seconding the original motion; and as it is also mentioned in the text, that is my construction of the original motion.

Mr. A. W. Johnston (New York, Chicago & St. Louis):—It was my fortune, some years ago, to be connected with the building of a Western line. We had about decided on the location of the road, and the character of its construction. An old engineer, who had long been a resident of that country, came to us for final instructions. He asked, "What kind of a railroad shall I locate?" I said to him, "You have been here a long time, and you understand the kind of a railroad we wish to have built in this Western country." He answered, "I guess I understand; you want an average Western railroad, capable of improvement." In this report of the Committee there is a suggestion that when

finances will not warrant, a certain thing should not be done. The inference to be drawn from the phraseology of the resolution would be that when the finances would warrant, it would then only be proper to do a certain thing. Now, any railroad company, building for the first time, will go as far as the money will permit, and, therefore, the inference to be drawn from this resolution, that it would not be proper for any railroad to build a cut with less than a certain width of roadway when they did not have the money, and that it would be proper when they did have the money, makes a wrong basis for ideal work. I would therefore move to strike out the expression, "when finances will warrant it." We are endeavoring to lay down an ideal condition, up to which it is hoped that at some time the average railroad will reach, if it has heavy traffic and fast traffic. We do not want to take the position that we should not do certain proper things, nor do we want to lay down an ideal which would not be proper under certain conditions. It seems to me the phraseology is awkward in that connection. I move to strike out the expression, "when finances will warrant it."

President Kittredge:—I think probably Mr. Johnston's remarks are slightly out of order on account of the motion to amend made by Mr. Cushing to add the sentence about the ditches.

Mr. Prout:—I move to incorporate the amendment made by Mr. Cushing in the original motion.

(Motion seconded and adopted.)

President Kittredge:—The resolution will stand as amended. Does Mr. Johnston wish to make an amendment now to strike out the words "when the finances will warrant it?"

Mr. Johnston:—I think it is wholly unnecessary, and I move to strike out those words.

Mr. J. H. Abbott (Baltimore & Ohio):—I second that motion heartily. If we are to have an ideal or standard to work up to, we do not want to limit it by a consideration of finances.

Mr. Edwin F. Wendt (Pittsburg & Lake Erie):—It seems to me we had better take one step farther and strike out the next sentence, "where the excavation can be used in embankments within reasonable haul." The Committee will probably admit at once that if there is no place within reasonable haul to put the extra material, it will be better to make a change in the line or grade

and use this extra material. We will not have the ideal practice unless we strike out the second clause.

President Kittredge:—I understand Mr. Wendt's remarks are in the way of a suggestion; there being a question before the house, it is hardly proper to consider any amendment at the present time. Is there any further discussion on Mr. Johnston's amendment? The Association should only put its stamp of approval on what is adopted after careful discussion. Even where all the members may think that the matter is worthy of approval, we should bring out its good points as well as its objectionable ones.

Mr. Prout:—Mr. President, it seems to me, sir, that in this Committee's report we ought to try to free our minds from an inheritance that we have from past generations of railroad builders; that is to say, within a very few years the conditions under which railroads are built in this country have changed absolutely. To-day money is very cheap. You can borrow it almost for nothing, if you borrow large sums and have good security, and we discover now that practically all of the railroads of the United States are being rebuilt. Therefore, we should put out of our minds the idea under which we have been working for a couple of generations now, of building our roads as cheaply as we possibly can, and we should start out on the proposition at this time that we should build as good railroads as we can; and that being so, I should be glad to have Mr. Johnston's motion prevail. I merely suggest this as being a sort of keynote or principle on which it seems to me we should proceed in dealing with this report; that is to say, we should cease to think of building as cheap railroads as we can, and get into the habit of building as good roads as we can, in order that our successors shall not have to build them over again at a much greater cost.

Mr. J. A. Atwood (Pittsburg & Lake Erie):—I wish to emphasize what has just been said by saying that we should get away from the construction idea in railroad building—which was to build cheaply and rebuild when dividends would warrant—and follow lines of construction that will give permanency of roadway. Our railroad enterprise is an assured success. Our business is assured, and improvements made must be made quickly and of best design. The service to be had from the improvements

is of much greater importance to us than the saving of a few dollars in first cost—therefore, make improvements of a permanent character, and be sure that they are designed in a manner to give the greatest service. I think the amendment is a proper one.

Mr. Abbott:—It seems to me the true idea we should have in mind when we are to build a railroad is not to build a cheap one, nor to build the very best, but to build it with a view to its use. If we are going to put heavy machinery in a building, we should construct a building which will support the machinery; but it would be ridiculous to build a heavy structure for a dwelling-house. I think it is the same way in regard to railroads. If we are going to build a line to tap a lumber district, we do not want to employ the best talent in engineering or in making the plans, constructing or supervising the work, or to use the heaviest rails, and all that sort of thing. We must take into consideration the use that is to be made of the road, and the possible and prospective earning power of the road. I do not believe that the present generation has got beyond that question yet—the prospective earning power of the road. If the road is located in such a situation that we may reasonably expect it to be a trunk line, or have a large business, then we certainly should put into it the amount of money that shall earn the most in return for the capital invested; and I really think that the true standard of our railroad construction must be the judicious expenditure of money in such a way that it shall bring the largest returns to the owners and to those who furnish the money.

Mr. Cushing:—Mr. Abbott's spirit of combativeness has led him away from the true conception of the work of this Association, as I understand it. Mr. Prout has well said that the great bulk of the work on railroads to-day is the rebuilding of the present lines. We are not thinking of new lines, as they form a small part of the railroad work of the present time. This work is made up of the rebuilding of the present lines, and that is why this Association was formed—so that we could gather ideas from each other and learn what each was doing in the rebuilding of his own line. We ought to bear that in mind in these discussions. There are very few of us who are chief engineers of new construction, or interested in any new construction, outside of small branch lines here and there; but we are nearly all of us engaged

to-day in endeavoring to improve the railroads we are working for. This work is predominant all over the country, and not confined to any one section; it is certainly predominant over the greater part of the country. I do not believe we should forget that this is what we are discussing, and not the building of new lines of road.

Mr. McNab:—Before proceeding to read the resolution as amended, I might say that the Committee have had in view first-class roads in keeping with modern requirements—first-class roads with heavy and incessant traffic, and first-class roads with less heavy traffic. They have not dealt with pioneer roads, or roads that may be used for temporary purposes. In regard to Mr. Johnston's amendment, I think it would be covered if we were to adopt the clause in its entirety, which begins on page 2 of the report, and simply says:

"Resolved, That in the theory upon which the width of embankment at subgrade is based, it is considered that the track in cuttings is placed upon what is virtually a low embankment, and in order to preserve uniformity of conditions immediately under the track throughout the line. the width of subgrade in cuttings should be made the same as on embankments, outside of which sufficient room must be allowed for side ditches."

That is the ideal condition. In regard to the next clause, it was intended to embrace the less important lines, but if the Association does not want to temporize with matters and simply have one ideal before them, then we should leave that clause in its entirety.

Mr. Cushing:—As far as I am concerned in this, I will accept the revision of the chairman of the Committee.

President Kittredge:—We will now take an inventory and see where we stand. The original motion was on the resolution as first written by the Committee. It is proposed by Mr. Johnston to amend it by striking out the words, "when finances will warrant." The chairman of the Committee was asked to rewrite his resolution, and he presents us with the sixth paragraph. on page 2, of the report, which covers the ground, but with different phraseology. The motion before the house is Mr. Johnston's amendment. We must dispose of that either by accepting it or voting it down, and taking up something else.

Mr. Johnston:—Mr. President, do I understand that the chairman of the Committee offers as a substitute a resolution with changed phraseology?

President Kittredge:—Yes, that is my understanding.

Mr. Johnston:—My only idea was to eliminate the notion that ideal practice would be affected by the condition of a man's pocketbook. Our friend who is going to build a logging railroad will not build a New York Central Railroad, but if the New York Central man desires to come up to a high ideal, we should not discourage him.

President Kittredge:—The motion we must act upon is the one which simply strikes out the words, "when finances will warrant it," from the resolution as originally written by the Committee.

(The amendment carried.)

Prof. C. Frank Allen (Massachusetts Institute of Technology):—If it is in order, I would propose the substitution of the resolution as presented by Mr. McNab.

President Kittredge:—Does the second of the original motion accept the substitution?

Mr. Raymer:—I accept the substitution.

President Kittredge:—The resolution now, as suggested by the Committee, and as accepted by Mr. Prout and his second, is, "In the theory upon which the width of embankment at subgrade is based, it is considered that the track in cuttings is placed upon what is virtually a low embankment, and in order to preserve the uniformity of conditions immediately under the track throughout the line, the width of subgrade in cuttings should be made the same as on embankments, outside of which sufficient room must be allowed for side ditches." As the matter stands, that is the resolution upon which the Association is to act, and, as I understand it, occupies the position of having been moved and seconded that it be accepted.

(Resolution adopted.)

The third resolution, as submitted by the Committee, is, that "local conditions should invariably be taken into account in determining the angle of repose in given material to be dealt with, and slopes should be varied to suit the character of the respective materials."

Mr. Wendt:—I move that the Association approve the resolution.

(Seconded by Mr. Cushing.)

President Kittredge:—It is moved by Mr. Wendt, and seconded by Mr. Cushing, that the resolution as read be accepted. The question is open for discussion.

Mr. W. B. Poland (Baltimore & Ohio Southwestern):—It seems to me that under this heading it would be very proper and desirable for the Committee to go into this matter much farther than they have. It occurs to me that under this heading there might be taken up to advantage the standard section which should be adopted for different kinds of ballast. It may be that that is covered by some of the other committee reports, but I do not at the present time remember that it is so covered, and if it is not, I offer as a resolution that this matter be referred back to the Committee, and that they be requested to submit at the next annual meeting the sections which they recommend for different classes of ballast, and show by diagrams the slopes which, in this statement, they say should be varied for different classes of ballast. I think this is one of the most important things in connection with maintenance, and it seems to me that this would be a proper place for this Committee to make their recommendations as to the exact sections to be adopted for, say, rock and slag or cinder and various classes of gravel.

President Kittredge:—The question of ballast and ballast cross-sections is treated by the Committee on Ballast, and is covered there fully. A distinct line has been drawn between the track superstructure and the roadway, and that line separates the ballast from what is called the permanent way, or, as is designated in this report, the roadway.

Mr. Abbott:—I think the gentleman who has just spoken raised the point in regard to the slope, which is very important. It has been my experience that the material which, in the form of natural bank, takes a certain slope, will not stand up under the wear and weather in a made bank at the same slope. I have made some study of that and find the embankment—the top of it—and the ballast acting as a kind of roof or shed, that the water falling upon it in heavy rains and running to the outer edge will wash out and give a curve to the top of the embank-

ment and roadbed, and at the bottom it will curve the other way, filling in at the bottom of the slope, and that, ultimately, doing that, it will give a lesser slope to the whole side of the embankment. If it is very high, the main portion of the slope between the top and bottom may show a little change, and I believe it is very good practice to make the slope for the material used in an embankment a little larger than you will find it in the state of the natural bank, especially when the natural bank has been held at the top by vegetation. I presume the Committee expected in another year to take up the question of the slope, judging from the remarks, "That the actual slopes to be offered will be examined later on," and I simply drop this in now as a thought, that the slopes should be greater than used in practice, because it will change under maintenance to a different slope than constructed.

Mr. McNab:—I think the resolution will cover all these features. The Committee has in view the securing of data in regard to the practice throughout the length and breadth of the country in slopes of different angles, various descriptions and material. We have said in our report that no definite angle is given because it varies in different classes of material, and also on account of the local features which obtain in almost every instance. We have in view the securing of information which will be brought out in subsequent reports.

President Kittredge:—I understand that the Committee has not completed its recommendations in all matters to be dealt with by it, and has simply submitted these resolutions as the ones which they feel they have discussed sufficiently to carry them down to a point where they can be either approved or not by the Association.

Mr. McNab:—That is right.

(The motion to adopt the resolution as read was carried.)

President Kittredge:—The remainder of the report of the Committee on Roadway is now before you. The Committee have followed the instructions given them by the Board of Direction, in so far as they have discussed and recommended for adoption by the Association such features as they feel had been worked out to such a point that they could be adopted. They have made no recommendations for us to take final action upon, but I suppose it is entirely proper to discuss the report in any way that the Association may desire.

Mr. McNab:—As to the two subdivisions which follow, the Committee's idea is that it should be taken home by the members of the Association and thought over between now and the next convention. I know it would hardly be reasonable to expect any person to take up this matter of grades in general and discuss it offhand; but our idea is that between now and the next convention it should be carefully considered and afterwards discussed as opportunity offered. The same may be said in regard to the matter of practical work, although that is paragraphed in such a way that we might get some valuable information from the present meeting, if some of the members who are actually engaged in that class of work will give to the meeting some points in their experience.

Prof. W. D. Taylor (University of Wisconsin):—I would like to ask why it is that the Committee recommends that a shrinkage should be allowed both horizontally and vertically, and would ask the Association whether or not there are any instances on record where an embankment has settled horizontally. If you allow, say, 10 per cent shrinkage, both horizontally and vertically, in two dimensions, the volume will be increased about 21 per cent, and embankments do not settle so much as this.

Mr. Hadley Baldwin:—I think myself that the expression, "shrinkage horizontally," is not correctly used in this connection. The decrease in cross-section, or decrease in horizontal dimensions, where it occurs, is always due to settlement vertically, and our resolution on caring for the slopes by giving proper angles will eliminate probably any necessity for recommending that extra width be made in the embankment.

President Kittredge:—It occurs to me that Mr. Taylor may have assumed that "horizontally" meant "longitudinally." I gathered from his remarks that he does not mean longitudinally.

Mr. C. S. Churchill (Norfolk & Western):—It seems to me the recommendation of the Committee, that the horizontal width be increased, is a correct one. This comes up especially in filling trestles and such work as that. You cannot change the grade of your track, as you do not want to put a hump in your road, and the common-sense way of handling the matter is to make your roadbed extra wide. About one foot in five is, in our experience, correct, and this has been our practice for several years.

The result is when a bank settles we have a wide space under our track that allows us to raise it up. It is a very simple matter to maintain width when there is a small raise to make, providing the footing exists on which to place that raise, and the whole object in making the bank wide is, therefore, to get the width on which to make the raise without going to the bottom of the large fill already made. Therefore, I think the recommendation would be complete if the Committee would leave out the vertical and adhere to the horizontal increase. Make a bank extra wide, but do not make it high, because you do not want a hump in your track.

Mr. McNab:—I appreciate Mr. Churchill's remarks in regard to the humps. Where you have a short fill or a series of fills to make, you would be apt to get a hump in your track if you made your fill proportionately high; but, generally speaking, where you have a long embankment, I think it is proper to increase both the height and the width.

Mr. Torrey:—I suppose the percentage in addition on account of the depth of fill is expected to apply to all work, part of which is building a second track. I think you scarcely want your old settled track two or three feet lower than a new track. It is cheaper to build a wide embankment and follow up with a second track.

Mr. Wendt:—Under the head of "practical work" there are a number of subjects which we may well pause to discuss. The tendency at the present time seems to be to use steam shovels of greater capacity, a three-yard dipper being now quite common in many parts of the country.

The Committee's recommendation that the gauge of track be standard should meet with our approval.

The subject of cars to be used in connection with construction work is one of great importance. About one year ago the Pittsburg & Lake Erie Railroad purchased one hundred steel flat cars, fully equipped with steel aprons, air-brakes and sideboards, and began using them in connection with steam shovels. These cars give excellent service and will carry twelve cubic yards of material, measured in excavation, without the use of sideboards.

The most economical method of unloading flat cars containing excavated material is by the use of an unloader. Attention is

called to the capacity of the old Lidgerwood unloader, which was 25 tons. It has been found in practice that a more powerful unloader was necessary to haul the plow over a train of flats loaded with ten or twelve cubic yards of material. The new style of Lidgerwood unloader has a capacity of sixty tons, and experience shows that an unloader of this capacity is necessary for satisfactorily unloading trains of flat cars.

It has been found by experience at times when an unloader would break down that it required one hundred laborers to do the same work which was done by the machine.

Investigation seems to show that there are very few spreaders in use in this country, and yet the great value of a spreader in the reduction of expense in connection with the leveling of material is well known. Their cost is generally from \$1,000 to \$1,500, including a car.

In general, I desire to compliment the Committee for the form and character of its report, which it seems to me is a valuable contribution to railroad literature.

Mr. F. H. McGuigan (Grand Trunk):—I just want to say to Mr. Wendt that I am sorry he admitted that when the Lidgerwood unloader broke he had to put one hundred men in its place, instead of substituting a locomotive, in case his admission should reach the ears of his General Manager.

Mr. Wendt:—Mr. Chairman, I am very glad to accept the criticism, but we did not have any locomotive for that purpose, the locomotives being what are called "teapots."

Mr. Cushing:—I think they are not making locomotives powerful enough to-day to unload a train of cars that could be unloaded with a Lidgerwood machine.

Mr. Atwood:—I would like to say also that I think it would be absolutely impossible for the "teapots" referred to to unload by plow cars loaded with three yards of material. The locomotives would not be powerful enough to plow them off.

Mr. McGuigan:—Mr. Chairman, I should like an explanation of that statement. I have been doing this sort of work for twenty years, and up to four years ago never knew what a Lidgerwood unloader was. We managed before we had rapid unloaders to unload cars with the same quantity of load, and I claim it is entirely possible, with an ordinary 17-inch cylinder engine.

to unload from any ordinary flat car seven or eight yards of material without a rapid unloader. We unloaded last year 200,000 to 300,000 yards without using either big engines or a rapid unloader.

Mr. Cushing:—The explanation is simple. The cars can be loaded so much heavier to-day on account of using the Lidgerwood machine that the locomotives cannot unload them. I have demonstrated that time and again. I do not say with sand or gravel or anything like that, but there is material which our friend here is handling, and which I myself have handled, that cannot be unloaded by a locomotive. You can load flat cars so heavily they cannot be unloaded.

Mr. McGuigan:—I again rise for an explanation. I would like to know what the material is.

Mr. Cushing:—Heavy clay and rock.

Mr. McGuigan:—I have been unloading that same kind of material, and do not think it is necessary to substitute one hundred men if an unloader breaks. I think you can do it with a small engine by exercising a little intelligence in the loading of cars.

Mr. Cushing:—That is very true. When cars are being unloaded with a Lidgerwood unloader and it breaks down, a certain amount of material has to be unloaded by hand before you can use the engine.

Mr. E. H. Lee (Chicago & Western Indiana):—I understand that the use of the Lidgerwood unloader and center plow has been very satisfactory in unloading with sideboards as high as three feet. I would like to ask if any member of the Association has had satisfactory experience in using a side plow under such conditions.

Mr. McGuigan:—I would answer the gentleman by saying that I have handled side plows for twelve or fifteen years with locomotives and without unloaders, handling heavy clay, gravel and sand.

President Kittredge:—How many yards on a car?

Mr. McGuigan:—From five to seven. It would depend on the character of the material and the distance we were hauling. Sometimes we would load the cars lighter and toward the outside.

Mr. Lee:—I would like to call attention to the fact that the question related to the use of a side plow on a car having the capacity of perhaps 25 or 30 yards. I have frequently used the side plow for unloading flat cars with sideboards of perhaps 10 or 12 inches, which could be removed from one side. I have information which I consider reasonably reliable as to the use of a center plow for unloading practically a gondola car. The particular information which I desire is whether any member of the Association has had experience as to the practicability of unloading a gondola car with swinging sides with a side-unloading plow.

Mr. H. F. Baldwin (Chicago & Alton):—We use a great many Haskell & Barker cars, and we have unloaded them with the side plow. We could not load them to their full capacity. We loaded them with possibly 15 or 20 yards, instead of 25 or 30 yards. The material was very sticky clay and broke off the stakes. We had a great deal of trouble in the stakes breaking off, but that was because of the character of the material. With gravel or sand we would have had no trouble, and could have easily handled the full capacity of the cars with the side unloader.

Mr. W. J. Harahan (Illinois Central):—We have used Lidgerwood unloaders for the last year with side plows. We have also used the center plow, mostly for unloading gravel and clay. Our experience with the Lidgerwood unloader has been very satisfactory. The cars hold about 38 yards, but I do not think we can unload more than 20 or 25 yards with a side unloader. My experience with the side unloader is that it takes a great deal more power to handle it than it does a center unloader, and ordinary flat cars of about 10 yards are about all they can handle when unloaded by locomotive.

Mr. Abbott:—I have had no experience with the high-sided cars, but I would like to say that we have done a good deal of work the last two years with flat cars with aprons, and we have not been able, with our small engines, to pull off a full load on flat cars with a side plow, but can do it with a center plow. Our side plow takes at least 50 per cent more power to pull than the center plow, and our cars with the aprons, loading continuously, have from 12 to 15 yards in sticky clay, such as we meet with in Cleveland, which is very treacherous stuff. When loaded in

a plastic condition we can get on some 20 yards, piling it up. Even with the center plow we use a high-class engine, although we have succeeded in getting it off in runs and starts with the center plow without using the highest class engine.

Mr. H. F. Baldwin:—I want to say, in explanation, in the work I refer to we have the very heaviest material to unload. I did not intend to say that with a locomotive we could pull off any such load.

Mr. Lee:—I would like to ask Mr. Baldwin whether he would feel justified, in the light of his experience, in again following the same practice, in dumping or handling stuff or clay such as he has described, by using a side plow, and whether the stake breakage was sufficient to deter him from such another attempt.

Mr. H. F. Baldwin:—Under the same conditions I would do the same thing again. The stake breakage was at a place where we have had to raise our tracks to about twelve feet, and the stakes broke off so badly that finally we had stakes only on one side, and we could not handle the matter very well, except with the side plows.

Mr. Wendt:—I do not question the statement that a locomotive can haul a plow over a train of flat cars and thus unload the material, but this statement is true only when the cars are loaded with reference to the capacity of the engine. It has been found in practice that a 10-wheel engine, with cylinders 18 by 24 inches, and 25,000 pounds' weight per driver, will not successfully and satisfactorily haul a plow over a train of cars when the cars are loaded beyond about seven cubic yards of material. Much depends upon the condition of the engine, whether it is in good repair or not.

Industrial conditions frequently compel the construction department to accept engines of very light capacity, and when insufficient motive power is assigned to construction work it will be economy to purchase an unloader and handle the plow with it.

Every transportation department wishes its engines to haul maximum loads, and it seems to me that the construction department should aim to load the flat cars much heavier and thus reduce the number of trains, and thus the train and engine mileage. If cars are to be loaded with some twelve cubic yards of material, it will not be satisfactory to unload the trains with

engines hauling the plow, and the purchase of an unloader will be a measure of economy.

Mr. W. L. Breckinridge (Chicago, Burlington & Quincy) :—We have unloaded ballast with both side and center plows. We found that there was a limit to the number of cars that could be unloaded by a locomotive. The material handled was burnt ballast.

Mr. Thomas L. Hanley (Grand Trunk) :—We have had the trouble of cables breaking every once in a while, caused by rough handling in unloading. We used to break our cables a great deal and we kept on hand a cable that would cover about fourteen cars. Our material ran all the way from sand to blue clay, and we used to take that train of twelve to fourteen cars and unload with a 19-inch cylinder engine.

Mr. Abbott :—I would like to ask the size of the cable.

Mr. Hanley :—Inch and a quarter to an inch and a half.

Mr. Abbott :—We have used the inch-and-a-quarter cable—used one four years, and got another last summer, and it has never broken. It is a little smaller than the gentleman speaks of, and we have never had any trouble. We had twelve to eighteen yards' load to the car.

Mr. Hanley :—All I have to say is that you are very lucky.

Mr. Abbott :—I think it is the fault of the cable.

Mr. Poland :—I would like to inquire the number of yards to the car that they unloaded.

Mr. Abbott :—We had twelve to eighteen yards.

Mr. McGuigan :—Mr. Wendt has evidently misunderstood me. Our experience with unloaders has been very satisfactory, and we have never had trouble with a Lidgerwood unloader or any other device of the same kind. My contention is that it is not necessary to substitute men for the unloader if it breaks down. With reference to the amount of material put on a car, I think it is very largely a question of the character of the work that you are doing. Much of the work we were doing, which Mr. Hanley speaks of, was cutting down track. We found we could cut deeper below the grade line by using flat cars than by using cars our friends of the Alton and some other lines were using. We had to use more cars to get the same quantity, but were more frequently able to complete the cutting to grade in a single trip

on account of cars being lower, where we should have been compelled to make two trips if using cars with high sideboards and of greater capacity.

Mr. E. E. Hart (New York, Chicago & St. Louis):—During the summer of 1895 I put in a fill at Nebraska City on the Burlington road, and did the plowing with an engine. We put in 200,000 yards, and we had no difficulty with the side plows, loading twenty to twenty-two yards on a car. The first few days we had trouble, but we lengthened the guides on the side plows eight or ten feet, so that the plow, in making its transit from car to car, entered the earth steadily, and we had no further trouble. Last summer we put in a large fill at Springfield, Pa. Here we used the Lidgerwood unloader. We have been putting on twenty to thirty yards to the car, and plow from side to side to hold our trestle in shape.

President Kittredge:—What kind of material?

Mr. Hart:—At Springfield, wet quicksand or very fine sand mixed with clay. The work referred to on the Burlington was clay, shale, rock, etc., but our success there was due to the use of the lengthened guides on the plow. We heightened our side plows and used a ten-inch board; somewhere in the neighborhood of twenty to twenty-two yards were loaded on a car. When using burnt ballast on the Burlington, we put on fourteen yards and had no trouble. The sideboards were about three feet high for burnt ballast.

Mr. W. M. Camp (Railway and Engineering Review—by letter):—The Committee expresses doubt as to the practical results of attempting to crown roadbed in the center to make it shed water. It is true that this scheme, which is indicated on the standard cross-section drawings of almost every railroad, is but seldom carried into practice. In my opinion such negligence is one of the worst mistakes that is made in railway construction. In cuttings it is an easy matter to crown the roadbed at the center, without extra expense, and the material is usually firm enough to preserve such a surface permanently. On a good share of the embankments that are built it is also a simple matter to properly shape the top of the roadbed in permanent form if the matter only received the necessary attention, as explained in my remarks in the discussion of the report on ballasting.

On roadbed for double track, where the embankment for the second track has been constructed by filling alongside an old embankment for single track, the drainage conditions at subgrade are even worse than are usually found with roadbed for single track. When filling is done in the manner stated, the slope of the shoulder of the old roadbed forms a natural drainage course lower than subgrade on the new roadbed, so that water from the old track tends to run into the space between the tracks, and the conditions do not admit of grading to shed water in both directions from this depression. Some double-track roads are using a tile drain under the midway, with side branches running under the tracks, and in other cases there is a ditch along the midway 8 to 12 inches below the bottom of the tie, with lateral drain boxes or tiling extending under the tracks. I suggest that it would be well for the Committee to investigate this method of construction, with a view to reporting upon results accomplished, and to recommend to what extent and under what conditions such construction is considered necessary.

President Kittredge:—The time is passing, and while I do not wish to curtail any discussion of a subject of so much importance as this is, still I feel as if it were necessary for us to pass on to some of the other subjects in order that we may get through our business. There being no motion before the house, unless there is some special request, we will declare this subject closed for the time being and the Committee dismissed.

I would like to call the attention of the chairmen, where the chairmen are present, and the vice-chairmen, where the chairmen are not present, of the various committees, to the advisability of having a meeting as early as practicable and before their subject is called for consideration by the Association. By doing this matters can be looked over and any omissions or any corrections which they desire made can be discussed by them and put in shape.

I will next call for the Committee on Track, Mr. Poland, of the Baltimore & Ohio Southwestern, chairman. The Secretary will read the Committee's names.

## REPORT OF COMMITTEE No. V.—ON TRACK.

*To the Members of the American Railway Engineering and Maintenance-of-Way Association:*

In presenting its report, your Committee on Track has endeavored to cover only five of the ten subjects assigned to it, leaving the remainder, as suggested by the Board of Direction, for future investigation.

Several of the subjects below have been discussed previously, but are now reported on with recommendations.

## I. MAINTENANCE OF LINE.

## (a) Adjustment of Tangents:

Recommendations: Tangents shall be adjusted by throwing the tangent between summits; between curves; or by throwing curves to meet tangent; or by partially throwing curves and by partially throwing tangents, as may produce the least work. Centers shall be set with transit to insure accurate line.

## (b) Adjustment of Curves, with Consideration as to Easement Curves:

Recommendation: Easement curves shall be used as follows:

For speed not exceeding 30 miles per hour, on all curves exceeding 2 degrees.

For speed not exceeding 60 miles per hour, on all curves exceeding 1 degree.

Where higher speed is attained, on all curves exceeding 30 minutes.

Easement curves shall be used between curves of different degrees in the same way that they are used between curves and tangents.

The length of easement curves shall be the same as the distance in which the curve elevation is run out; therefore, as the super-elevation of curves depends not alone on the degree, but also on the speed of trains, the length of the easement curve should vary in the same manner.

For ordinary practice, a chord length equivalent to 100 feet for each degree of variation in curvature is recommended.

Where the distance between curves will not allow this, or for other reasons, a chord length of 25 to 30 feet may be used.

For very high-speed roads, a chord length equivalent to 150 feet or more per degree of variation is recommended.

Your Committee believes that any form of transition curve is satisfactory which gradually changes the degree of curvature, and in which the length of chord per degree of variation can readily be changed to suit each particular case, the essential point being that the length of the easement curve shall be the same as the distance in which the super-elevation of curve is raised from 0 to full elevation.

We recommend any transition curve of the Searles, Crandall, Holbrook, Talbot or cubic parabola type, which shall be susceptible of being run in by deflection or offset.

## (c) Method of Securing and Maintaining Perfect Line:

Recommendations: Permanent witnesses shall be placed at points of tangent, points of spiral, points of change of curvature, summits, and at such other points along curves or tangents as will enable the alignment to be identically reproduced with a transit.

## 2. MAINTENANCE OF SURFACE.

- (a) Elevation of Curves, with special consideration as to amount and beginning and end of elevation, and as modified by location of curve and conditions of traffic:

Recommendations: The inner rail shall be maintained at grade.

Your Committee advises that the approximate formula,

$$E = \frac{G V^2}{32.16 R}$$

in which,

E = elevation in feet,

G = standard gauge, 4.708 feet,

V = velocity in feet per second,

R = radius of curve in feet.

will give essentially correct theoretical elevations for the outer rail of curves, and is recommended for ordinary practice, but must be modified to suit special conditions.

This formula will give results which are expressed in the accompanying table, and are recommended for use, with the modifications given below:

Deg.	VELOCITY IN MILES PER HOUR.												Deg.	
	10	15	20	25	30	35	40	45	50	55	60	65		70
1	$\frac{1}{16}$	$\frac{1}{8}$	$\frac{3}{16}$	$\frac{1}{4}$	$\frac{5}{16}$	$\frac{3}{8}$	$\frac{1}{2}$	$\frac{5}{8}$	$\frac{3}{4}$	$\frac{7}{8}$	1	$1\frac{1}{8}$	$1\frac{1}{4}$	1
2	$\frac{1}{8}$	$\frac{1}{4}$	$\frac{1}{2}$	$\frac{3}{4}$	$1\frac{1}{8}$	$1\frac{1}{4}$	$1\frac{3}{4}$	$2\frac{1}{8}$	$2\frac{1}{2}$	$2\frac{3}{4}$	3	$3\frac{1}{4}$	$3\frac{1}{2}$	2
3	$\frac{1}{4}$	$\frac{3}{8}$	$1\frac{1}{8}$	$1\frac{1}{4}$	$1\frac{3}{4}$	$2\frac{1}{8}$	$2\frac{3}{4}$	$3\frac{1}{8}$	$3\frac{1}{2}$	$3\frac{3}{4}$	4	$4\frac{1}{4}$	$4\frac{1}{2}$	3
4	$\frac{3}{8}$	$1\frac{1}{8}$	$1\frac{3}{4}$	$2\frac{1}{8}$	$2\frac{3}{4}$	$3\frac{1}{8}$	$3\frac{1}{2}$	$4\frac{1}{8}$	$4\frac{1}{2}$	$4\frac{3}{4}$	5	$5\frac{1}{4}$	$5\frac{1}{2}$	4
5	$\frac{1}{2}$	$1\frac{3}{4}$	$2\frac{1}{4}$	$3\frac{1}{8}$	$3\frac{1}{2}$	$4\frac{1}{8}$	$4\frac{1}{2}$	$5\frac{1}{8}$	$5\frac{1}{2}$	$5\frac{3}{4}$	6	$6\frac{1}{4}$	$6\frac{1}{2}$	5
6	$\frac{5}{8}$	$2\frac{1}{4}$	$3\frac{1}{4}$	$4\frac{1}{8}$	$4\frac{1}{2}$	$5\frac{1}{8}$	$5\frac{1}{2}$	$6\frac{1}{8}$	$6\frac{1}{2}$	$6\frac{3}{4}$	7	$7\frac{1}{4}$	$7\frac{1}{2}$	6
7	$\frac{3}{4}$	$2\frac{3}{4}$	$4\frac{1}{4}$	$5\frac{1}{8}$	$5\frac{1}{2}$	$6\frac{1}{8}$	$6\frac{1}{2}$	$7\frac{1}{8}$	$7\frac{1}{2}$	$7\frac{3}{4}$	8	$8\frac{1}{4}$	$8\frac{1}{2}$	7
8	$\frac{7}{8}$	3	$5\frac{1}{4}$	$6\frac{1}{8}$	$6\frac{1}{2}$	$7\frac{1}{8}$	$7\frac{1}{2}$	$8\frac{1}{8}$	$8\frac{1}{2}$	$8\frac{3}{4}$	9	$9\frac{1}{4}$	$9\frac{1}{2}$	8
9	1	$3\frac{1}{4}$	$6\frac{1}{8}$	$7\frac{1}{8}$	$7\frac{1}{2}$	$8\frac{1}{8}$	$8\frac{1}{2}$	$9\frac{1}{8}$	$9\frac{1}{2}$	$9\frac{3}{4}$	10	$10\frac{1}{4}$	$10\frac{1}{2}$	9
10	$1\frac{1}{8}$	$4\frac{1}{4}$	$8\frac{1}{4}$	$9\frac{1}{8}$	$9\frac{1}{2}$	$10\frac{1}{8}$	$10\frac{1}{2}$	$11\frac{1}{8}$	$11\frac{1}{2}$	$11\frac{3}{4}$	12	$12\frac{1}{4}$	$12\frac{1}{2}$	10
11	$1\frac{1}{4}$	$5\frac{1}{4}$	$10\frac{1}{4}$	$11\frac{1}{8}$	$11\frac{1}{2}$	$12\frac{1}{8}$	$12\frac{1}{2}$	$13\frac{1}{8}$	$13\frac{1}{2}$	$13\frac{3}{4}$	14	$14\frac{1}{4}$	$14\frac{1}{2}$	11
12	$1\frac{3}{8}$	$6\frac{1}{8}$	$12\frac{1}{8}$	$13\frac{1}{8}$	$13\frac{1}{2}$	$14\frac{1}{8}$	$14\frac{1}{2}$	$15\frac{1}{8}$	$15\frac{1}{2}$	$15\frac{3}{4}$	16	$16\frac{1}{4}$	$16\frac{1}{2}$	12
13	$1\frac{1}{2}$	$7\frac{1}{8}$	$14\frac{1}{8}$	$15\frac{1}{8}$	$15\frac{1}{2}$	$16\frac{1}{8}$	$16\frac{1}{2}$	$17\frac{1}{8}$	$17\frac{1}{2}$	$17\frac{3}{4}$	18	$18\frac{1}{4}$	$18\frac{1}{2}$	13
14	$1\frac{5}{8}$	$8\frac{1}{4}$	$16\frac{1}{4}$	$17\frac{1}{4}$	$17\frac{1}{2}$	$18\frac{1}{4}$	$18\frac{1}{2}$	$19\frac{1}{4}$	$19\frac{1}{2}$	$19\frac{3}{4}$	20	$20\frac{1}{4}$	$20\frac{1}{2}$	14
15	$1\frac{3}{4}$	$9\frac{1}{4}$	$18\frac{1}{4}$	$19\frac{1}{4}$	$19\frac{1}{2}$	$20\frac{1}{4}$	$20\frac{1}{2}$	$21\frac{1}{4}$	$21\frac{1}{2}$	$21\frac{3}{4}$	22	$22\frac{1}{4}$	$22\frac{1}{2}$	15
16	$1\frac{7}{8}$	$10\frac{1}{4}$	$20\frac{1}{4}$	$21\frac{1}{4}$	$21\frac{1}{2}$	$22\frac{1}{4}$	$22\frac{1}{2}$	$23\frac{1}{4}$	$23\frac{1}{2}$	$23\frac{3}{4}$	24	$24\frac{1}{4}$	$24\frac{1}{2}$	16
17	2	$11\frac{1}{4}$	$22\frac{1}{4}$	$23\frac{1}{4}$	$23\frac{1}{2}$	$24\frac{1}{4}$	$24\frac{1}{2}$	$25\frac{1}{4}$	$25\frac{1}{2}$	$25\frac{3}{4}$	26	$26\frac{1}{4}$	$26\frac{1}{2}$	17
18	$2\frac{1}{8}$	$12\frac{1}{4}$	$24\frac{1}{4}$	$25\frac{1}{4}$	$25\frac{1}{2}$	$26\frac{1}{4}$	$26\frac{1}{2}$	$27\frac{1}{4}$	$27\frac{1}{2}$	$27\frac{3}{4}$	28	$28\frac{1}{4}$	$28\frac{1}{2}$	18
19	$2\frac{1}{4}$	$13\frac{1}{4}$	$26\frac{1}{4}$	$27\frac{1}{4}$	$27\frac{1}{2}$	$28\frac{1}{4}$	$28\frac{1}{2}$	$29\frac{1}{4}$	$29\frac{1}{2}$	$29\frac{3}{4}$	30	$30\frac{1}{4}$	$30\frac{1}{2}$	19
20	$2\frac{3}{8}$	$14\frac{1}{4}$	$28\frac{1}{4}$	$29\frac{1}{4}$	$29\frac{1}{2}$	$30\frac{1}{4}$	$30\frac{1}{2}$	$31\frac{1}{4}$	$31\frac{1}{2}$	$31\frac{3}{4}$	32	$32\frac{1}{4}$	$32\frac{1}{2}$	20

Since the elevation required is a function of, and depends upon, the train speed, this speed is the first element to be determined.

In general, as a matter of safety, the preference should be given to fast passenger traffic. The slower freight traffic must also be considered,

and it often happens that on freight lines the correct elevation for passenger service would be so excessive for freight service that the train resistance would be increased enough to materially reduce the tonnage hauled. In this case, a compromise must be made between the two rates of speed, and the curve elevation used will be too small for passenger service (theoretically), but practicable for freight service.

When the theoretical elevation is reduced the speed of passenger trains should be correspondingly reduced. This is a problem which must be decided on each road, according to the relative importance of its freight and passenger traffic.

It must not be understood that it is unsafe to run over a curve at a higher rate of speed than that for which it is elevated. A train may safely run 10 miles per hour over a curve which has no elevation. In the same manner a train may safely run 60 miles an hour over a curve elevated for a speed of but 50 miles an hour. Such an extreme should be avoided. It results in increased flange and rail wear and cost of maintenance. The curve can never ride perfectly and the danger of accident is increased.

The maximum allowable elevation of curves depends entirely on local conditions. On fast passenger roads, where crushed stone or other stiff ballast is used, a difference in elevation of 8 inches is successfully maintained, and your Committee recommends that for ordinary practice a maximum elevation of 8 inches shall be used, but that when greater elevation is required, speed shall be reduced until the 8 inches elevation gives satisfactory results.

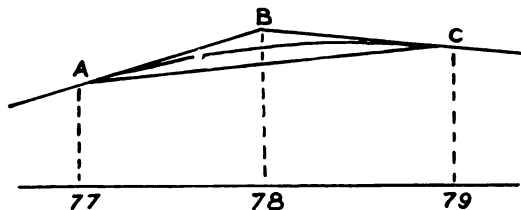
The super-elevation of curves shall be zero at the point of spiral and shall increase to full elevation at the end of the spiral or point of simple curve.

In ordinary practice, it is recommended that the elevation be run out at the rate of 1 inch in 60 feet, but this will be modified by the same conditions that should vary the length of the easement curve used.

#### (b) Vertical Curves:

Recommendations: Vertical curves shall be used wherever changes occur in the rate of grade.

Theoretically, the changes in the rate of grade for each station of the vertical curve should be equal. A section of a parabola as applied to this purpose so nearly approximates this condition that the following formula is recommended for practical use:



Let AB, BC be two grades in profile, intersecting at station B, and let A and C be the adjacent stations. It is required to join the grades by a vertical curve extending from A to C. Suppose a chord drawn from A to C. The elevation of the middle point of the chord will be mean of the elevations of grade at A and C. One-half of the difference between this and the elevation of grade at B will be the middle ordinate of the curve. Hence we have:

$$M = \frac{1}{2} \left( \frac{\text{grade A} + \text{grade C}}{2} - \text{grade B} \right)$$

in which M = the correction in grade for the point B. The correction for any other point is proportional to the square of its distance from A or C. Thus the correction at A + 25 is 1-16 M; at A + 50, it is  $\frac{1}{4}$  M; at A + 75, it is 9-16 M; and the same for corresponding points on the other side of B. The corrections in the case shown are subtractive, since M is negative. They are additive when M is positive, and the curve concave upward. (See Searles.)

The proper length of vertical curves depends on the difference in rate of grade of the intersecting tangents. As a rule, we recommend that such curves should not be less than 200 feet or more than 800 feet long.

(c) Proper Methods of Tamping:

(1) Earth or Clay Ballast.—Recommendations:

Tools: Shovel equipped with iron cuff or handle for tamping; broad pointed tamping bars.

Work: Tamp each tie from 18 inches inside of the rail to end of tie with handle of shovel or tamping bar. If possible, tamp the end of the tie outside of rail first and let train pass over before tamping inside of rail; give special attention to tamping under the rail; tamp center of ties loosely with the blade of the shovel; the dirt or clay between the ties must be placed in layers and firmly packed with feet or otherwise, so that it will quickly shed the water; the earth must not be banked above the bottom of the ends of the ties; the filling between the ties must not touch the rail and should be as high as, or higher than, the top of the ties in the middle of the track.

(2) Cinder Ballast (Railroad Product):

Tools: Shovel, tamping bar or tamping pick.

Work: Same as for earth and clay ballast.

(3) Burnt Clay Ballast:

Tools: Shovel only in soft material. When burnt very hard, tamping pick or bar should be used.

Work: Tamp 15 inches inside of rail to end of tie, tamping end of tie first, letting train pass before tamping inside of rail; tamp center loosely; tamp well between the ties; dress ballast same as for earth or cinders.

## (4) Broken Stone or Furnace Slag:

Tools: Shovel, tamping pick, stone forks.

Work: Tamp 15 inches inside of rail to end of tie; if possible, tamp the end of the tie outside of rail first and allow train to pass over before tamping inside of rail; tamp well under the rail; tamp well under ties from end of same; do not tamp center of tie; fill in between ties to height of top of tie; bank ballast into shoulder about the end of the ties level with top of tie.

## (5) Chat, Gravel or Chert Ballast:

Tools: Shovel, tamping pick or tamping bar. For light traffic, shovel tamping is sufficient. For heavy traffic, the tamping pick or tamping bar should be used. The tamping pick is recommended instead of the tamping bar for ordinary practice.

Work: Tamp solid from a point 15 inches inside of rail to the end of the tie; if possible, tamp the end of the tie outside of the rail first and allow train to pass over before tamping inside of rail; care must be taken not to disturb the old bed. Tie must be tamped solidly from the end, using pick or tamping bar. After train has passed, the center of the tie shall be loosely tamped with the blade of the shovel. Whether the material shall be banked around the ends of the ties or not will depend upon how well the ballast will drain.

(6) In all surfacing the level board shall be used at least at joints and quarters, and on high-grade track at every tie.

## 3. MAINTENANCE OF GAUGE.

## (a) Proper Method of Spiking:

Recommendations: The gauge shall be a wooden bar with circular metal arcs fastened rigidly to it for gauging surfaces.

(2) The gauge shall be used whenever a spike is driven.

(3) Outside spikes shall be started straight with face of spike in contact with base of rail; the spike should never have to be straightened while being driven.

(4) Outside spikes of both rails shall be on the same side of the tie, and the inside spikes on the opposite side of the tie. The inside and outside spikes shall be separated as far apart as the face and character of the tie will permit. The ordinary practice shall be to drive the spike  $2\frac{1}{2}$  inches from the outer edge of the tie.

(b) Allowance, if any, in Gauge of Curve, with consideration as to various practices:

The widening of gauge as an allowance for curvature is a matter of such importance that your Committee considers that further investigation should be made before recommendations are submitted.

In order not to reproduce matter already printed, we refer you to the discussion of this subject, beginning on page 275 of the Proceedings

of the Second Annual Convention. Your Committee believes that the manner in which the subject is there presented is the correct method of theoretical solution.

By reference to plates No. 1, No. 2 and No. 3, of above report, it appears that there are only a few types of engines where, theoretically, any widening of gauge is required for curves under about 7 degrees, and none which require gauge of curves of less than 4 degrees and 30 minutes to be widened.

Your Committee is not, however, decided that the practical consideration of flange and rail wear may not make it advisable to widen the gauge when not required theoretically, and will reserve its decision until the time of the next report.

It is suggested that your Committee on Track arrange to discuss this matter jointly with the Committee of the American Railway Master Mechanics' Association, if this method is approved by the Board of Direction.

- (c) Methods used to prevent spreading of track and canting of rails on curves:

Recommendations:

- (1) For heavy traffic, use tie-plates on all ties on curves.
- (2) For medium traffic, tie-plate all curves over 3 degrees.
- (3) For light traffic, double spike the outside of rails.
- (4) Tie-plates are recommended in preference to rail braces except for guard rails and stock rails at switches, where the latter should be used.

#### 4. INSPECTION OF TRACK.

- (a) Trackwalking, consideration as to, when to be resorted to, and particular requirement of:

Recommendations: Except in case of roads of very light traffic, all main track shall be inspected each day by section gang or trackwalker. Trackwalker shall be sent out over territory not covered by section gang in the day's work.

Trackwalker or patrol shall be sent out in case of heavy storms, wash-outs, etc., and during the time when falling stone slides, etc., are to be expected.

The trackwalker shall be provided with spike maul, spikes, wrench and train signals. His duties shall be to carefully inspect the track and roadway, fences, bridges and culverts, and, in general, guard against all damage or danger to any railroad property.

In case of trouble he will put out torpedoes, or other danger signals needed to protect trains, and will notify the proper officers from the nearest possible point.

- (b) Special Inspection of Switches, Frogs, Crossings, Derailing Points, Interlocking Plants, etc.; Requirements:

Recommendations: Section foreman or trackwalker shall make a close daily inspection of all switches, frogs, crossings, derail points, inter-

locking plants, etc., on the main line, and as frequent inspections of same off the main line in yards, spur tracks, etc., as his work will permit.

In case any weakness or defects are found, the foreman shall immediately report same to the proper employé, and in his absence make such repairs as he is able to make, whether the work is under his charge or not. In case temporary repairs cannot be made, the section foreman or other employé discovering the defect must be held responsible for the giving of proper notice, and the protection of trains, until the defect can be remedied.

(c) Inspection of Bridges, Trestles, Culverts, etc., by Trackmen:

(Covered by a and b.)

(a), (b), (c) Supervisors or roadmasters shall make close monthly inspection of all track details on their entire territory.

A formal annual or semi-annual inspection shall be made by the division officers in company with section foremen of all track details and equipment, to determine if the same are being maintained in the proper manner and kept up to the standard.

## 5. TOOLS.

(a) Track Tools—Various Kinds:

Recommendations:

(1) Bars, Claw: The goose-neck bar is not recommended on account of the variation in the curve and because of bending the spikes in drawing. The straight claw bar with long heel shall be used.

(2) Bars, Lining: Shall be of steel, just as light as they can be made and not bend under track-throwing. They shall have wood chisel point,  $1\frac{1}{2}$  inches square at lower end for 15 inches, and taper to  $\frac{3}{4}$  at the top; length, 5 feet 6 inches.

(3) Bars, Tamping: Lower edge shall be 4 inches by  $\frac{1}{2}$  inch; upper end chisel-pointed.

(4) Bender, Rail: For curving rail and heavy rail bending the roller type of bender shall be used. For bending stock rails, etc., a "jim crow" may be used.

(5) Boards, Elevation (or sighting), for Surfacing Track: Shall be 12 to 14 feet long, painted black, with  $\frac{3}{4}$ -inch white strip, the top of which is to be used for sight line. This strip to be in two equal parts, which can be raised or lowered on the board independently by pegs and series of holes  $\frac{1}{4}$  inch apart. The board to be set level by means of adjustable iron legs. In surfacing around a curve, the outer strip shall be raised the amount of the elevation. Sight to be taken from a block at the eye over a block at the jack to the top of the strip. (See Figure A.)

(6) Boards, Dap: (See Figure E.) The board shall be thoroughly seasoned. The gauging edges shall be set to a true plane. This board is to be used to adze all ties so that the rails shall set on a true plane. No tie shall be put in track until tested and made true by use of this board.

(7) Digger, Post-hole: The scissor type shall be used in preference to hollow cylinder or auger.

(8) Drills, Track: For yard construction and switch work the crank power drill shall be used, supplied to foreman from supervisor's headquarters. For regular section work, a ratchet drill will be used.

(9) Gauges: The gauge shall be a wooden bar with metal arcs fastened rigidly to it for gauging purposes. The arcs shall be cycloidal curves, such that the distance between points of contact with the rails shall be constant and equal to standard gauge. This prevents any variation through not setting the gauge at right angles to rails.

(10) Jacks, Light: For regular section work a light ratchet jack shall be used; capacity, 4 to 5 tons, 10-inch raise.

(11) Jacks, Heavy: For ballast, surfacing or construction gangs, when heavy work is required, a heavy ratchet or friction jack shall be used; capacity, 10 tons, raise 16 inches.

(12) Levels: The boards shall be thoroughly seasoned. Level tube shall be adjustable. One end of board shall be fitted with a slide bar and set screws for elevation of curves.

(13) Picks, Tamping: Tamping end should be 3 inches by  $\frac{5}{8}$  inch.

(14) Shovels, Track: These shovels should be No. 2 size. They should have an iron handle, or iron cuff, for handle tamping ties, if used on mud ballast track.

(b) Standard Equipment for Gangs:

The following standard equipment for gangs is recommended. (The quantity will necessarily vary according to force employed and general character of road. See pages 64 and 65.)

(c) Hand Cars—Types in Use:

(1) Light Section Cars: These shall be made strong and durable, even at the expense of lightness. The platform shall be  $4\frac{1}{2}$  feet by 6 feet. Handles, iron; axles,  $1\frac{1}{8}$  inches. Great attention shall be given to see that the axles are set well apart, near end of sills.

(2) Heavy, Extra Gang: Platform 5 feet 6 inches by 8 feet. Handles, iron; axles, 2 inches. In this case, as above, it is of the utmost importance that the axles be set as far apart as practicable to avoid the possibility of unequal weight on ends of cars unbalancing it while running. Many serious accidents have occurred from the neglect of this feature in hand-car construction.

(d) Push Cars—Types in Use:

Each section and yard gang shall have a push car. Platform,  $5\frac{1}{2}$  feet by 7 feet; axles, 2 inches. Axles shall be placed as near the end of sills as possible to prevent same from breaking down or sagging.

Rail gangs may be equipped with a rail or "Larry" car. This has rollers at each end for sliding rail on or off. It is to be heavily built throughout.

The beds of push cars and rail cars shall cover the wheels.

(e) Dump Cars:

Each section, ballast or dressing-up gang shall be equipped with a dumping device to be applied to push cars, which will dump on either side of car and dump quick. The platform shown in Figure B is recommended. This can be set on any push car, is easily removed and put out of the way when not wanted, and can be dumped in an instant by one man, thus avoiding the danger of working on main track with a permanent dump car.

For yard gangs, permanent dump beds may be furnished for dump cars. These may be side dumps (Figure C), or if cinder pit can be reached (Figure D).

(f) Method used in supplying and checking use of:

(a) In ordering material the Foreman shall make requisition on the Supervisor.

(b) The Supervisor shall make requisition on the Division Engineer or other superior officer, or storekeeper.

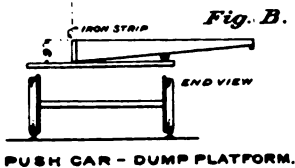
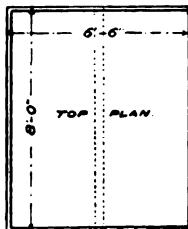
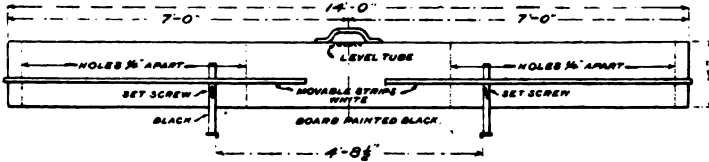
(c) Material shall be sent out directed to Supervisor or Foreman. A manifest shall be sent to the Supervisor, on which the material is charged against him.

(d) Supervisor shall keep book account with each section, and charge Foreman with all material sent him during the month, and he shall keep account of material released.

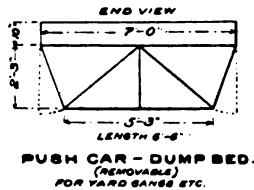
(e) Section Foreman shall make monthly tool report to Supervisor, which must check with the Supervisor's book account.

TRACK TOOLS.

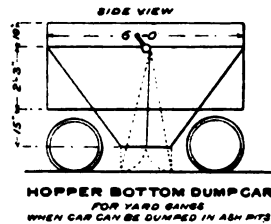
*Fig. A.*



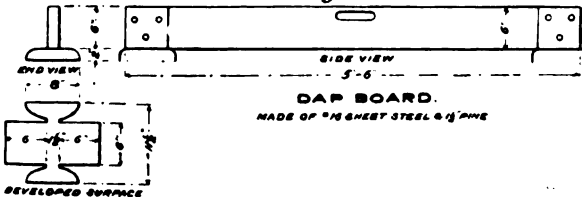
*Fig. C.*



*Fig. D.*



*Fig. E.*



*Fig. F.*



# STATEMENT OF TOOL EQUIPMENT RECOMMENDED FOR REGULAR AND EXTRA GANGS.

DESCRIPTION OF TOOLS.	EARTH BAL.	GRAVEL BALLAST.		STONE BALLAST.		RAIL LAYING	REMARKS.
	Section Gang, 3 Men.	Section Gang, 4 Men.	Extra Surfcg. Gang, 25 Men.	Section Gang, 5 Men.	Extra Surfcg. Gang, 25 Men.	Extra Gang, 30 Men.	
Axes, Chopping.....	1	1	1	1	1	1	
Adzes.....	1	2	4	2	4	8	
Bars, Claw.....	2	2	4	4	2	10	
"    Lining.....	3	4	12	5	12	12	
"    Nipping, for holding ties to while spiking.....	..	..	2	..	2	..	} Fork which fits over Rail and under Tie Tamping Picks recommended to be used in place of bars except for earth ballast.
"    Tamping.....	3	4	10	..	20	10	
Blades for Brush Hooks (extra) ..	2	2	..	2	..	..	
Bits for Ratchet Drill.....	2	2	..	2	..	..	
"    Power Drill.....	..	..	..	..	..	4	
Brace, Carpenter.....	1	1	..	1	..	..	
Bits for Carpenter Brace.....	3	3	..	3	..	..	
Boards, Elevation for Surfacing Track.....	1	1	1	1	1	1	
Boards, Dap for Adzing Ties....	1	1	2	1	2	..	
Boxes, Tool, Extra Gangs.....	..	..	1	..	1	1	
Book Rules.....	1	1	1	1	1	1	
Brooms, Common.....	2	2	..	2	..	3	} Increase No. in Snow Country and in Yards.
Brushes, Whitewash.....	2	2	..	2	..	..	
Buckets, Water.....	1	1	3	1	3	3	
Cars, Hand, Small.....	1	1	1	1	1	1	
"    Extra Gang.....	..	..	1	..	1	1	
"    Push.....	1	1	1	1	1	1	
"    Velocipede.....	..	..	..	..	..	..	} For Lamplight- ers, Inspectors, etc., under spec- ial conditions.
"    Rail (or "Larry Car")....	..	..	..	..	..	1	
Chains, Push Car Lock.....	1	1	2	1	2	2	
Chisels, Track.....	3	3	3	3	3	12	
Cans, Oiler, Handcar.....	1	1	2	1	2	2	
"    2 Gal.....	1	1	1	1	1	1	
"    5 ".....	1	1	..	1	..	..	
Cups, Tin.....	1	1	2	1	2	2	
Drills, Stone.....	2	2	..	2	..	..	} Rock Country only
"    Rail, Power.....	..	..	..	..	..	4	
Diggers, Post Hole.....	1	1	..	1	..	..	
Dippers, Tin.....	..	..	2	..	2	2	
Files, Large Flat.....	2	2	..	2	..	..	
"    Hand Saw.....	1	1	..	1	..	..	
Forks, Rail (rail gang).....	..	..	..	..	..	2	
"    Ballast (rock ballast)....	..	..	..	4	15	2	
Flag Covers, Tin.....	1	1	1	1	1	1	
Flags, White (or Green).....	2	2	2	2	2	2	} Where used as Signals.
"    Red.....	4	4	4	4	4	4	
"    Green (or Yellow).....	4	4	4	4	4	4	
Gauges, Track.....	1	1	3	1	3	3	
Grindstones, complete.....	1	1	..	1	..	..	
Globes, Lantern, White (extra) ..	1	1	1	1	1	1	
"    "    Red.....	1	1	1	1	1	1	
"    "    Green.....	1	1	1	1	1	1	
"    "    Yellow.....	1	1	1	1	1	1	
Hatchets.....	2	2	..	2	..	..	
Hooks, Brush, complete.....	2	2	..	2	..	..	
"    Tie.....	1	2	4	..	4	..	
Hammers, Stone.....	..	..	..	2	2	..	} Rock Ballast or Rock Country only.
Handles, Extra for Axe.....	1	1	1	1	1	1	
"    "    Adze.....	1	1	3	1	3	3	
"    "    Pick.....	2	2	4	2	4	4	
"    "    Sledge.....	1	1	3	1	3	3	
"    "    Stone Ham'rs.....	..	..	..	1	2	..	} Rock Country only.

**STATEMENT OF TOOL EQUIPMENT RECOMMENDED FOR REGULAR  
AND EXTRA GANGS—CONTINUED.**

DESCRIPTION OF TOOLS.	EARTH BAL.	GRAVEL BALLAST.		STONE BALLAST.		RAIL LAYING	REMARKS.
	Section Gang, 3 Men.	Section Gang, 4 Men	Extra Surfcg. Gang, 25 Men.	Section Gang, 5 Men.	Extra Surfcg. Gang, 25 Men.	Extra Gang, 30 Men.	
Handles, Extra for Spike Maul ..	2	2	4	2	4	6	{ For breaking track out of mud and for extra heavy work. For ordinary work substitute 5-ton jacks.
Jacks, Track, Light, 5 tons .....	1	2	4	2	4	..	
"    Heavy, 10 tons.....	..	..	2	..	2	..	
Kegs, Water .....	1	1	2	1	2	2	
Lanterns, White, complete .....	2	2	2	2	2	2	
"    Red .....	2	2	2	2	2	2	
"    Green .....	2	2	2	2	2	2	
Levels, Track .....	1	1	1	1	1	1	
Mauls, Spike .....	2	2	6	3	6	12	
Mattocks, Grubbing .....	1	1	..	1	..	..	
Picks, Clay .....	2	2	10	3	..	3	{ Recommended, but Bars can be substituted except for Stone Ballast.
"    Tamping .....	..	2	20	5	20	..	
Platforms, Dumping for Push Cars	1	1	1	1	1	..	
Pliers, Wire .....	1	1	..	1	..	..	
Punches, Rail .....	1	1	1	1	1	3	
Rail Bender, Complete .....	..	..	..	..	..	1	
Rakes .....	1	1	..	1	..	..	
Ratchet for Track Drills (extra).	1	1	..	1	..	..	
Saws, Hand .....	1	1	1	1	1	1	
"    Crosscut .....	1	1	1	1	1	1	
Scythes, complete, Briars, Brush and Grass .....	3	4	..	5	..	..	{ Fitted with iron cuff for mud bal- last. As maybe needed in snow latitudes, or where coal is handled.
Scythes, Blades for Grass (extra)	1	2	..	2	..	..	
"    "    Briars .....	1	1	..	1	..	..	
"    "    Brush .....	1	1	..	1	..	..	
Shovels, No. 2 Track .....	3	4	25	5	20	12	
"    Scoop .....	..	..	..	..	..	..	
Stretchers, Wire Fence .....	1	1	..	1	..	..	
Sledges, weight 12 lbs .....	1	1	4	1	4	4	
Tape Lines .....	1	1	1	1	1	1	
Templet, Standard Roadbed .....	1	1	1	1	1	..	
Tongs, Rails .....	..	..	..	..	..	8	{ Or Barrows to run on rail.
Torpedoes .....	12	12	12	12	12	12	
Wheelbarrows, Iron .....	1	1	..	1	..	..	
Wrenches, Track .....	3	3	2	4	2	10	
"    Monkey .....	1	1	1	1	1	1	
Whetstones .....	3	3	..	4	..	..	

**SUPPLIES CARRIED AT HEADQUARTERS.**

(SUPERVISORS' OR ROADMASTERS')

To be sent out as needed and returned when work is completed.

DESCRIPTION OF TOOLS.	NUMBER.	REMARKS.
Bender, Rail, Roller Type, complete...	1	
Block and Falls, 1½ in., with Lines...	1	
Car, Light Inspection .....	1	
Digger, Post Hole .....	4	
Drills, Rail, Power .....	1	
Lights, Wells' or Buckeye Type .....	1	
"    Flares (Coal Oil or Gasoline)	6	For Wrecking.
"    Torches .....	24	For Wrecking.
Mower, Lawn .....	1	For Wrecking.
Plow, Ditching, Heavy .....	1	
Shovels, Long-handled .....	12	
"    Scoop .....	12	
Spades, Ditching .....	12	
Saw, Rail, Power .....	1	
Wheelbarrows, Track .....	12	Fitted to run on rail or ground.

Supervisors will also hold at headquarters a small number of emergency tools and extra parts.  
This supply should be as small as experience on each road shows to be safe.

This report shall be made on sheet divided into columns as follows:

- (1) Description of tools.
- (2) Tools on hand at first of month.
- (3) Number disposed of.
- (4) How disposed of.
- (5) On hand at last of month.

An inventory of all tools shall be taken once every six months. The Foreman's report "on hand at last of month" must check with this.

In requesting new tools the Foreman shall be required to return the old tools, or give a satisfactory reason for not doing so.

Your Committee respectfully submits to the Association for adoption the following:

"RESOLVED, That this Association accepts and endorses the recommendations of the Committee on Track as to the following subjects:

#### 1. MAINTENANCE OF LINE.

Recommendations as to—

- (a) Adjustment of tangents.
- (b) Adjustment of curves, with consideration as to easement curves.
- (c) Method of securing and maintaining perfect line.

#### 2. MAINTENANCE OF SURFACE.

Recommendations as to—

- (a) Elevation of curves, with special consideration as to amount and beginning and end of elevation, and as modified by location of curve and condition of traffic.
- (b) Vertical curves.
- (c) Proper methods of tamping—tools and method of work, in different kinds of ballast.

#### 3. MAINTENANCE OF GAUGE.

Recommendations as to—

- (a) Proper method of spiking.
- (b) Allowance in gauge of curve.
- (c) Methods to prevent spreading of track and canting of rails on curves.

#### 4. INSPECTION OF TRACK.

Recommendations as to—

- (a) Trackwalking—consideration as to, when to be resorted to, and particular requirements of.
- (b) Special inspection of switches, frogs, crossings, derailing points, interlocking plants, etc.; requirements.
- (c) Inspection of bridges, trestles, culverts, etc., by trackmen.

#### 5. TOOLS.

Recommendations as to—

- (a) Track tools—various kinds.
- (b) Standard equipment for gangs.
- (c) Hand-cars.
- (d) Push-cars.
- (e) Dump-cars.
- (f) Method to be used in supplying and checking use of.

Respectfully submitted,

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F. R. COATES, C. G. W. Ry., St. Paul, Minn.;  
D. MACPHERSON, C. P. Ry., Montreal, Can.;  
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H. C. LANDON, B. & S., Galetton, Pa.;  
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W. H. DAVISSON, C., R. I. & P., Chicago, Ill.;

*Committee.*

President Kittredge:—We will listen to any remarks which the chairman of the Committee on Track may have to offer. I will let the chairman explain why the report was delayed, and will not blame him unnecessarily.

Mr. W. B. Poland (Baltimore & Ohio Southwestern):—Mr. President and Gentlemen: I presume that most of the chairmen will have to come before the meeting with apologies. I know that in my own case I have made very good resolutions, but just before this subject was to be prepared and sent out we had quite a bad strike on our road, which tied us up practically for a month, and afterward there was another month's delay, so that the matter had to be held, as far as I was concerned, for nearly two months, and it was for that reason that the report was not gotten in to the Secretary in time to be sent out.

The report of the Committee on Track last year was very severely criticised, because the conclusions were not put in the form of recommendations or resolutions. I fear that we may possibly have gone a little too far in the other direction this year. The discussion has been to a considerable extent eliminated, and the conclusions or recommendations of your Committee have been stated in this report on the supposition that whatever was necessary would be brought out in the discussion in the meeting.

In regard to the matter of easement curves, which is the subject considered under the heading (b) of Maintenance of Line, while your Committee has made recommendations in regard to it, and in regard to it and some other subjects under Maintenance of Surface, we do not want to be considered as making final recommendations on these matters. We do consider that, as far as we have gone, we are right, or we would not have made the recommendations; but we feel that it is possible to get up some

valuable and concise tables for expressing the proper elevation for the outer rail of curves and for the proper distance to which the elevation of the outer rail shall be run out, which has not been worked up this year, but which we hope to present at the next meeting.

By referring to the report, you will notice that your Committee has presented its conclusions under the form of recommendations, and I presume that the recommendations are in form to be discussed as resolutions before the meeting.

President Kittredge:—You have before you the report of the Committee on Track, and the recommendations of the Committee. It seems to me that it would be advisable for us to take these up in the order in which they are given. For example, under the head No. 1, Maintenance of Line, the Committee submits for acceptance and endorsement the recommendations of adjustment of tangents, as set forth in the report. Unless there is some objection to this plan, we will call for action of the Association in regard to the adjustment of tangents recommended.

In order that we may properly discuss that, it would be in order for someone to make a motion that the recommendations under the head, "Maintenance of Line," "Adjustment of Tangents," as set forth in subdivision *a*, should be accepted or endorsed, and by doing that we can get the matter properly before the Association for discussion.

Mr. W. C. Cushing (Pennsylvania Lines):—I move that the Association endorse the report.

(Motion carried.)

President Kittredge:—Action will be taken on subdivision *b*, the adjustment of curves, with consideration as to easement curves. What is the pleasure of the Association in regard to that subdivision?

Mr. Cushing:—In order to bring it before the Association, I move that it be accepted.

(Motion seconded.)

President Kittredge:—It is moved and seconded that subdivision *b*, Maintenance of Line, be accepted. The question is now open for discussion.

Mr. Cushing:—I would like to ask the Committee in regard to the last paragraph and the recommendation printed in the

smaller type, "For very high-speed roads, a chord length equivalent to 150 feet or more per degree of variation." I would like to have some reasons presented.

Mr. Poland:—The reason for adopting 150 feet chord length was in order to have the distance in which the elevation of the outer rail of the curve should be run out from full elevation to zero correspond with the length of the spiral. If it were not necessary to run out the outer elevation of the curve, it would not be necessary to have a spiral. For a very high-speed road, the rate of elevation must be very gradual. By very high-speed roads, I am referring to roads where a speed between stations of from 65 to 80 miles an hour is customarily obtained. For a one-degree curve, for such a rate of speed, the elevation for seventy miles an hour would be three and a half inches. If that elevation were run out at the ordinary rate of, say, one inch in sixty feet, it would require a distance of about 200 feet to run from zero to the full elevation. At the rate of 70 or 80 miles an hour, it is questionable whether that is a sufficiently easy approach from zero to full elevation, and it is for that reason that the spiral should be correspondingly slight and the curve approach correspondingly easy. I know of but one or two spirals which are worked out for such a long approach. The cubic parabola can be figured for any rate of approach very easily, and I think that Crandall's spiral is also susceptible of being strung out for such an easy approach.

Mr. Cushing:—The reasons are not clear to me yet, because I do not think the chord length is a function of the speed at all. The chord length is really a function of the degree of curve, or sharpness of the curve. The stakes are put in for the benefit of the trackman—for no other earthly reason. They are put in for his benefit in aligning the curve proper. The sharper the curve, the more frequent the stakes should be to enable him to get it properly, and a 150-foot chord, which is longer than the tapes customarily used, is certainly a very inconvenient chord to use in running curves. I fail to grasp the pertinency of considering the speed in connection with it at all. It is a track matter. It is for the benefit of the track foreman—the trackman—in putting up the curve properly, and I would not wish to approve of a recommendation of that kind. The other

part of the recommendation seems to be right and proper, but instead of lengthening the chord we should shorten the chord for the benefit of the trackman in getting good alignment.

Mr. Poland:—I think there is a misconception on the part of Mr. Cushing as to what was referred to by the chord length. It was not at all meant that the stakes of the spiral should be set at 150 feet or any other specified distance apart. Probably a distance of fifty feet would be the extreme length at which they should be set. The chord length is merely mentioned as a measure of the degree of the spiral. It will be noticed that I speak of the length of chord per degree of variation. It is simply the distance in which one degree of variation is made in the rate of spiral, and refers not at all to the manner in which the spiral should be staked out.

Prof. C. Frank Allen (Massachusetts Institute of Technology):—The Committee recommends “any transition curve of the Searles, Crandall, Holbrook or cubic parabola type, which shall be susceptible of being run by deflection or offset.” I am sorry that there is not included with that the name of Talbot. The Talbot curve is a very good curve. I should be glad to have the name introduced, and make a motion to that effect.

Mr. Poland:—In mentioning the names here we probably have again given a wrong impression. It was not the Committee’s idea to say to the Association that we recommend these spirals in preference to others, but these spirals which are mentioned are probably as universally known as any, and we thought in mentioning them we would give to the Association as correct an idea as possible of what we considered a proper and practicable spiral. It is not meant that we do not consider that a great many other spirals are equally as good, and possibly better, than the ones mentioned, under some conditions.

Prof. Allen:—Talbot’s curve is very much in line with Crandall’s, Searles’ and Holbrook’s. It is used to some extent in this country. I don’t wish to advocate it unnecessarily. It is a matter in which I have no personal interest whatever; I do not use this curve myself, but believe it would be valuable to the Association to have their attention called to it in connection with the others. It is really a very good curve, of just the same type as the Crandall and Holbrook.

President Kittredge:—Is there a second to Mr. Allen's amendment that the word "Talbot" be inserted?

Prof. W. D. Pence (Purdue University):—I second Prof. Allen's motion.

President Kittredge:—It is moved and seconded that the recommendation of the Committee be amended by the insertion of the word "Talbot," along with the words "Searles, Crandall and Holbrook." The question is now upon the amendment.

Mr. W. J. Harahan (Illinois Central):—Why not take out all the specific names and simply specify the type? I think if we specify the types, without specifying individual names, it would be better than to specify any name at all.

President Kittredge:—Will Mr. Harahan suggest the wording of the sentence that should be substituted for this?

Mr. Harahan:—Just strike out the names and simply recommend the character of the curve—the spiral curve—which is advisable.

Mr. Poland:—The types mentioned here—the Searles, Crandall and Holbrook, or cubic parabola type—possibly should have been reversed a little rhetorically, and possibly I should have said "curve of the type of the Searles, Crandall, Holbrook, or cubic parabola." The idea was to say that it was the type which those spirals represent, and not those particular spirals. Possibly that would satisfy the gentleman.

President Kittredge:—The question is now on the amendment, inserting the word "Talbot." Those in favor of the amendment will signify by saying aye, contrary no.

(The amendment was carried.)

President Kittredge:—The original question is now before you on the adoption of subdivision *b*.

Mr. L. S. Rose (Cleveland, Cincinnati, Chicago & St. Louis):—It seems to me the wording of paragraph *b* is a little ambiguous. "Easement curves shall be used as follows: For roads not exceeding a speed of 30 miles per hour, on all curves exceeding 2 degrees; for roads not exceeding speed of 60 miles per hour, on all curves exceeding 1 degree; for roads where higher speed is attained, on all curves exceeding 0 degrees 30 minutes."

Prof. Allen:—It would meet the matter to say, "for speeds not exceeding 30 miles an hour, on all curves exceeding 2 degrees."

Mr. Rose:—I move that the wording of the paragraph be changed so that it will indicate that these specifications are for the various speeds for the curves in question, not for the roads.

Mr. H. F. Baldwin (Chicago & Alton):—I take exception to the criticisms these gentlemen have made. It is perfectly clear what this report says, and what it means, as far as I can see. No change should be made in the wording of it, because it says: "Easement curves shall be used as follows: On all curves exceeding 2 degrees for roads not exceeding a speed of 30 miles per hour." You can read that either way you please. I do not think we ought to waste time changing the phraseology of this thing. I think the important thing to devote our attention to is whether or not we agree with these recommendations. You might quibble all day over the wording of them and not accomplish anything. We are here to do something.

Mr. Cushing:—I move the amendment to that paragraph which I have already criticised be stricken out as being misleading and not having much meaning to it.

Mr. Wendt:—I will second that.

President Kittredge:—It is moved and seconded that the ninth paragraph under subdivision *b*, which reads, "For very high-speed roads, a chord length equivalent to 150 feet or more per degree of variation is recommended," be amended by striking that from the report.

Mr. A. Torrey (Michigan Central):—I think, perhaps, that particular language is not well chosen, but I understand the meaning of it to be that where you have a very high speed around curves there must be a certain distance where the variation of the curve is not greater than one degree, and perhaps the word "distance," instead of "chord," might answer. All of us know that it is a compound curve. When short chords and large variations in the degrees of the successive curves are used, it is not nearly so comfortable as when longer chords and very slight variations are used, and I take it the Committee meant that in a distance of 150 feet no greater curvature should be attained from the tangent than one degree, and no greater curvature from that point should be attained than two degrees in the succeeding 150 feet, etc.

Mr. Cushing:—I do not believe everybody understands that the same way. The rate for grade of elevation is the controlling feature in easement elevation, not the length of chord used. That is simply a matter of mechanical work. For very high speeds, perhaps, you would want a little easier grade, but it is not specified in that way, and I think it is entirely misleading as to what it means.

Mr. J. A. Atwood (Pittsburg & Lake Erie):—I think that the clause as it stands is correct, and I think that it should remain. I think that for high speeds, from 65 to 85 miles an hour, it is sufficient that there should be 150 feet in which to reach the degree of curvature specified, and also the necessary elevation that is proper for that degree of curvature. Therefore, I think the recommendation is correct as it stands.

Mr. Wendt:—I seconded this amendment, because I did not understand what the Committee meant in this paragraph. Mr. Torrey explained it in a different way, and by changing the phraseology probably the Association could adopt the recommendation of the Committee. I will say, in our experience, we have used spirals of 100 feet in length per degree of curve for 1-degree curves. For 3-degree curves or 4-degree curves, we have used spirals of the length of 60 feet per degree of curve, meaning the length of the spiral on a 4-degree curve would be four times 60, or 240 feet, these lengths being used where the speed was maximum. Where the speed was 30 miles per hour, we have been using a length of 20 feet per degree of curve, or on a 5-degree curve 100 lineal feet. If the Committee mean their recommendation in the light of an explanation of this character, I think I could see my way clear to fall in with it.

President Kittredge:—It occurs to me that the language of any recommendations that we make should be so plain that there could not be any misunderstanding. Now, personally, I understand what the Committee was striving at was to have the wording such as not to be misleading, but if to one or two members it would seem desirable to change it, so that there can be no misunderstanding as to just what is meant, I think Mr. Torrey's explanation would put the matter clearly before us as to the wording. While Mr. Baldwin's remarks were very pertinent, we do

not want to quibble too much over phraseology, but we do want to have such words used as are clearly understood.

Mr. T. L. Hanley (Grand Trunk):—I think it will be plain to every one of us to leave out the word "chord" and say "length equivalent to 150 feet or more per degree of variation."

Prof. Allen:—Do I understand that "per degree of variation" means the degree of curve, so that for a 4-degree curve the length of spiral would be 600 feet?

President Kittredge:—Six hundred feet from a tangent to a point of 4-degree curve, the distance of easement of the curve would be 600 feet.

Prof. Allen:—That is, 600 feet for a variation between a tangent and 4-degree curve, or for a variation between a 1-degree curve and a 5-degree curve.

President Kittredge:—The question now is upon striking out that clause.

Mr. Poland:—In dealing with spirals, it is necessary for us to have some way of measuring or designating a spiral. There are many different kinds of spirals worked out from many different theories, which, as a matter of fact, in practical application, approach each other so closely that it seems to me that we can designate the spiral satisfactorily by its chord length, meaning by that chord length such a distance as is required to vary the rate of curvature one degree. The designation of a curve by degrees is, of course, customary. This means that the deflection is so many degrees in a chord length of 100 feet, or that the central angle of the subtangent is a certain amount. Now, in discussing spirals, we must adopt some measure of the spiral, and the one that has appeared to your Committee most satisfactory and easily understood is to designate it by its chord length—that is, the distance in which there is a variation of one degree in the rate of curvature—and that is what is meant when we say that we should, for ordinary curves, use a chord length of 100 feet. We mean that in a distance of 100 feet the rate of curvature should vary one degree. If we say a chord length of 50 feet, we mean that in the distance of 50 feet the rate of curvature shall vary one degree, and if we say a chord length of 150 feet, we mean that in the distance of 150 feet the rate of curvature shall vary one degree. I know of no other way of satisfactorily designating a spiral than

by this chord length variation. That does not mean at all that the chord shall be staked out in those distances. Because you have what you might call a 50-foot spiral, does not mean that you should put stakes in for 50 feet; you could put them in for 10, 15 or 25 feet—any distance you want. I do not think that the last paragraph should be left out, for this reason, that if we do leave it out, the report, as it will stand before the meeting, will mean that we would recommend a chord length of 100 feet for very high-speed roads. Now, I do not think that a spiral in which the variation of one degree in 100 feet is used is the proper one for extremely high-speed roads, and it was for that reason that a longer chord length was recommended. If the paragraph is not satisfactory, I would suggest that we strike out the exact distance, if that is the sense of the meeting, and simply say that for high-speed roads, a greater chord length be used than 100 feet per degree of variation.

Mr. Cushing:—The discussion has brought out clearly what it means now, and while I do not agree with the language in it, I have no wish to quibble on language, as Mr. Baldwin says, and I withdraw the motion.

President Kittredge:—Mr. Cushing and his second have withdrawn the motion to strike out the clause under discussion.

Mr. Rose submits the following as an amendment to paragraph 2, subdivision *b*: "Easement curves shall be used as follows: For speed not exceeding 30 miles per hour, on all curves exceeding 2 degrees; for speed not exceeding 60 miles per hour, on all curves exceeding 1 degree; where higher speed is attained, on all curves exceeding 30 minutes."

Has that amendment any second?

(Seconded.)

It is moved and seconded that the three paragraphs of the report be amended as read. Is there any discussion?

(Amendment carried.)

Now the question is, shall the article as amended be adopted by the Association?

Mr. Torrey:—I see nothing in these recommendations indicating that on a double-track road any different policy should be pursued in preparing the curves. I think there is no question that the rate of incline, to attain the superelevation, should be

less as you approach the curve than as you leave it, to produce the same sensation. The easement at the remote end of the curve can be shorter, and at the same speed, than the easement at the entrance. I do not know why, but I know it is so, and I presume we aim at perfection, and I suggest that some mention of it be embodied in the recommendations.

President Kittredge:—Mr. Torrey has brought up an interesting question. I am free to confess that the subject had never occurred to me, and I think it would be advisable to hear further on that point. It occurs to me, however, that one thing should not be overlooked in these days when double tracks are liable to be used in both directions, that what is the approach of the curve in operating in one direction is not the approach to it in operating from the other direction, and we must not lose sight of the fact that we are trying to provide for all cases.

Mr. Torrey:—It would be perfectly safe, either way; but it would work out, in my opinion.

Mr. J. H. Abbott (Baltimore & Ohio):—May it not be that the speed of the train is reduced somewhat in passing around the curve? Now, in practice, on the single track road I am connected with, for high degrees of curvature, I do not use the same calculated elevation as I do on the lighter degrees, because our trains, on the sharper curves, are reduced in speed—our local conditions are such that it reduces the speed—and I use 40 miles an hour for up to 4 degrees of curvature, and then I have a system of dropping it off, figuring on the sharper curves, which run up as high as 8 degrees curvature—of course, too much for trunk lines. And I have noticed that same thing in regard to leaving a curve.

President Kittredge:—Mr. Torrey, do you wish to make an amendment?

Mr. Torrey:—No; I am not prepared to make an amendment. I cannot do much in that connection.

President Kittredge:—Do you wish to submit it in writing? We will give you time.

Mr. Torrey:—Is it intended that these recommendations are to be acted on finally at this meeting?

President Kittredge:—Only by so doing can we make progress, but not at this session. The time for closing the session

is near at hand. I will suggest that during the noon intermission you formulate such amendment as you think would be applicable to the question in hand, and we will discuss it then.

As I have said a good deal about being prompt in convening, I suppose we ought to be prompt in closing our sessions, and we will therefore consider for the time being that the Committee is dismissed.

(Recess until 2 o'clock.)

### AFTERNOON SESSION.

President Kittredge called the meeting to order at 2 o'clock p. m.

President Kittredge:—If the members of the Committee on Track will kindly take their places on the platform, we will proceed with the discussion.

When the adjournment to noon recess was taken, the subject under consideration was subdivision *b* under "Maintenance of Line." It had been moved and seconded that the recommendations of the Committee be approved. These recommendations had been amended as regards the first three paragraphs and the phraseology changed. It was suggested by Mr. Torrey that they be further amended, and he was given time to prepare his amendment and submit it in writing upon the convention coming to order again.

Mr. Torrey:—I would like to withdraw that amendment.

President Kittredge:—Mr. Torrey wishes not to submit any amendment.

As the matter stands now, we are ready to vote on the whole of section *b*, as amended. Is there any further discussion?

(Motion put and carried.)

President Kittredge:—The third item under subdivision *c* is the method of securing and maintaining perfect line. The recommendations of the Committee are that permanent witnesses shall be placed at points of tangent, points of spiral, points of change of curvature, summits, and at such other points along curves or tangents as will enable the alignment to be identically reproduced with a transit. What will you do with this recommendation of the Committee?

Mr. Hunter McDonald (Nashville, Chattanooga & St. Louis) :—I ask if the Committee considered the best way of establishing the permanent witnesses, whether to put them in the center of the track or at the side. I notice they are silent on that point.

President Kittredge :—I suggest that a motion be made to adopt the article, and then it can be discussed.

Mr. McDonald :—I move that the article be adopted.

President Kittredge :—Discussion of this article is now in order.

Mr. McDonald :—I ask if the Committee considered the best means of establishing these witnesses, whether to put monuments in the center of the track or place them at the side, and let them act as witnesses as well as signboards for the proper elevation?

Mr. Poland :—That subject was considered in the Committee meeting, and it was thought best not to go into that detail. Local conditions would vary so much that it was considered it might not be best to make a specific recommendation as to how such centers should be established. Probably the most usual way would be to set rails in the center of the track, because they are available and easy to set. A monument on the side of the road was considered, but a good many embankments would be so likely to settle that we thought that it would not be proper to recommend that monuments be put on the side, because it would not apply to all cases, and a man would invariably be governed in establishing monuments by his local conditions. We maintain that a permanent mark should be used at such points that the line can be accurately reestablished by the use of the transit.

(The section was adopted.)

President Kittredge :—We will now take up subdivision 2 of the report, "Maintenance of Surface." The first section of this subdivision *a* relates to the elevation of curves, with special consideration as to amount and beginning and end of elevation, and as modified by location of curves and conditions of traffic. Perhaps Mr. Poland will open the discussion on this subject.

Mr. Poland :—It would possibly be proper for me to say a few words in regard to this section. The recommendation of the Committee as given here is that the lower rail shall be maintained at grade. The Committee recognizes the fact that that is

not theoretically correct. The theoretically correct method of elevating curves would be to depress the inner rail and elevate the outer rail, the point being that the ideal condition would be one in which the center of gravity of the train would not be disturbed, not be raised or lowered, in passing around the curve; that is, that no work would have to be done on the train in inclining it as it follows around the curve to give the necessary elevation. But, practically, the amount which the low rail should be depressed is less than the amount which the high rail should be elevated; and for other practical considerations in the field your Committee considered that equally good results would be obtained by holding the inner rail at grade and elevating the outer rail. We recognize the fact that in very sharp curves it might be necessary to depart from this. The attention of your Committee was called to one particular curve, where an 8-inch elevation was used, where it had been necessary, in order to get a good riding track, to lower the inner rail; but we consider, as a general proposition, a general rule, that it would be perfectly satisfactory to hold the inner rail at grade. The formula given in the report is not theoretically correct, but is so closely correct that your Committee considered that it was practically applicable in all cases; that is, a slight variation in the speed of the train would make so much more variation in the elevation in the outer rail than would be occasioned by the difference between the use of this formula and the theoretically correct formula, that we considered that it could be disregarded and this formula used.

Prof. W. D. Taylor (University of Wisconsin):—I would suggest the advisability of substituting for  $G$ , relating to the standard gauge, the figures 4.9 feet, instead of 4.7 feet; 4.7 is the proper gauge; but the distance between points of supports, the center of rail heads, comes nearer to 4.9 than to 4.7. I offer that as an amendment.

President Kittredge:—Will the Committee accept Mr. Taylor's amendment, or shall we get a second and put it to a vote?

Mr. Poland:—I do not think that the Committee would feel like accepting that amendment without working it out. The results worked out from the formula as they stand vary less than one-eighth inch for different speeds from results worked out by the absolutely correct theoretical formula, which difference,

we felt, could be disregarded, and while I am quite convinced that the adopting of 4.9 in place of 4.7 would make very little difference, without actually working it out, I do not feel I would like to subscribe to it. It might be all right, and possibly closer than the results given.

Mr. Abbott:—Six inches is our maximum elevation on a coal road. Our passenger trains run 40 and 45 miles an hour around 4-degrees curves, and yet with that elevation our inside rail (80-pound rail, which is a little bit soft) has formed a lip on the outside of the rail, showing a sliding of the wheels of our freight trains down the incline of 6 inches elevation, and it is a serious question whether we should not reduce our elevation rather than make it greater. I bring that up as an experience.

President Kittredge:—Is there any further discussion on the amendment to substitute 8 inches for 7 inches as the maximum elevation? If there is no further discussion, the question will be put.

(The motion was put and carried.)

President Kittredge:—We will now proceed with the adoption of the whole section as amended.

Mr. D. D. Carothers (Baltimore & Ohio):—It seems to me it will be necessary to have the paragraph which has just been under consideration read correctly to change the reference to the eight as well as the seven. The paragraph is as follows: "On fast passenger roads, where crushed stone or other stiff ballast is used, a difference in elevation of eight inches is successfully maintained, but your Committee recommends that for ordinary practice a maximum elevation of seven inches shall be used."

Mr. D. W. Lum (Southern Railway):—Would not the use of the word "and" instead of "but" make the sentence read correctly?

President Kittredge:—The Committee accepts the substitution of the word "and" for the word "but."

Mr. Cushing:—I feel that the Committee has been a little conservative in recommending a maximum elevation of 7 inches. Eight inches is being very largely used and is perfectly safe and convenient. It allows for much better regulation in regard to speed, and I would be in favor of changing the 7 inches to 8 inches. I would therefore make an amendment that the figure 7

be changed to 8, in regard to the maximum allowable elevation of curves. I have known of cases of passenger tracks to be elevated 9 inches, and I think 8 is perfectly safe and within reason, and I suggest that be the figure instead of 7.

Mr. Poland:—I would only call attention to the fact that the statement is here made that for "ordinary practice" 7 inches is recommended. Your Committee considered the extreme elevations that are frequently used. They are used, I presume, only on strictly passenger roads and under special conditions. It would be perfectly satisfactory to the Committee to change that to 8 inches if the sense of the meeting is that an elevation of 8 inches could be considered "ordinary practice." I also ask, if it was so changed, whether we should not eliminate the expression "ordinary practice."

Mr. Cushing:—I heartily appreciate what the chairman of the Committee says in regard to "ordinary practice." What I recommend is certainly ordinary practice on the Pennsylvania Lines. I think that it is good for any road that wants to maintain a speed of at least 45 miles an hour, because many roads have 6-degree curves, and 8 inches is the elevation for a 45-mile-an-hour speed. I do not think that is an excessive elevation for almost any road running pretty good passenger service. These curve elevations are on both freight and passenger tracks; both kinds of traffic pass over them and they are entirely practicable and satisfactory.

Mr. Churchill:—While this matter is up, I wish to bring up another point that is raised in connection with this. What I refer to is the statement made, "The slower freight traffic must also be considered, and it often happens that on freight lines the correct elevation for passenger service would be so excessive for freight service that the train resistance would be increased enough to materially reduce the tonnage hauled. In this case a compromise must be made between the two rates of speed." I think this is a question which must be settled, as the Committee says, by every railroad company; and I think that clause has great weight in modifying the paragraph which is under discussion—that the error has been committed heretofore in some cases of having too high an elevation where there is heavy freight. The question is, how high can you get the elevation and not cause

any trouble to your freight trains, if you are running passenger and freight trains on the same track? I want to ask a question in connection with this. The statement is made in the paragraph just quoted that the train resistance would be increased enough to materially reduce the tonnage hauled. That is contrary to many publications heretofore made, notably that of Wellington. Mr. Wellington compiled experiments and stated that it made no difference what the elevation be in amount, the result of the elevation was to decrease the train resistance. The statement just quoted holds directly the opposite opinion, namely, that the train resistance may be increased by high elevation.

This point has been up several times. It is a live question with our road. The statement of the Committee is so directly opposite to many publications that we all know of, that I think we want to settle the question. We cannot elevate track fully to suit the highest speed passenger train, if we are going to run freight trains over the same track. Take, for example, from my standpoint, a curve of 10 degrees. Everyone knows that in running a high-speed train on a 10-degree curve, at 35 or perhaps 40 miles an hour, the important question is how high shall the elevation be—shall we go to 7 inches? It is found not absolutely necessary to go to 7 inches, and there is constant pressure being brought to lower this figure in favor of freight trains, rather than to raise it. I do not know exactly why it should be so, but it seems from the movement of freight cars, when down on their side bearings, there is some argument that can be brought to bear for having the elevation a little low, rather than too high, in the case of freight trains. I would like to have some light on that point—whether there is an increase in train resistance due to the fact that you have a little more elevation than the particular train in question requires. Your freight train on curves runs 10 miles per hour, and your passenger train runs 40 miles an hour. By putting a 7-inch elevation in your track, are you bringing too much train resistance on your freight train? This is a live question for those handling freight trains.

Mr. D. W. Lum (Southern Railway) :—We have all kinds of railroads represented in this meeting, but I think the men on the different roads are very much alike. There are many curves, and very frequently these curves are sharp and are at the foot

of grades. It does not make any difference whether the engineer is on a passenger train or on a freight train, when he goes down the hill and strikes the curve, he is going pretty nearly as fast as he can, unless someone is there to stop him, and if we happen to be on a delayed train, as I was in reaching this city to-day, I would not have tried to stop him. I do not think 8 inches is an excessive elevation for such cases. At the top of grades, where the curve might be 10 or 12 degrees, such an elevation would not be necessary, nor would it be attempted. I think this report, in recommending 7 inches, would perhaps restrict elevation more than need be at some points. I know of some curves at the foot of steep grades where 8 inches elevation is not excessive. I hope no one here has such curves.

Mr. Churchill:—I hope my point will be considered before this matter is finally decided.

Mr. Poland:—The object in elevating the curve, as your Committee understands it, is to insure that the reaction through the center of gravity of the train, the resultant action, which is a combination of the centrifugal force and the gravity, shall be normal to the plane of the track. It is to accomplish this that the curve is elevated. If the curve is elevated correctly, the reaction will be normal to the plane of the track, and in that condition the running of the train around the curve should be, as far as its reaction is concerned, and the work done, exactly the same, leaving out the question of flange friction, rolling friction, as it would on straight track. Now, if your curve is not elevated correctly, if it is elevated either too much or too little, the centrifugal force forces the wheels against the outer rail, if the elevation is too little, or the gravity component forces the flanges of the wheels against the inner rails, if the elevation is too great. In either case, if it is not correctly elevated, there must be more work expended in pulling the train around the curve than if it were correctly elevated. That seems to me so self-evident a proposition that I cannot see where any discussion should come in on it.

Mr. Churchill:—My question is answered, except that the answer leaves out the important element of friction of the flanges on the track and these arguments which I have referred to. As a matter of fact, the friction of the flanges of the wheel on the

outer rail is actually decreased by a little superelevation, and the result is, if there is superelevation—that is, too much elevation for freight trains—nevertheless, it is not injurious, because a freight train will move a little easier. We all have observed that the lower rail forms a lip on the outside often; that is due to the extra weight brought on the low rail by the freight train; but at the same time I think we have observed there is no material wear on the inside rail produced by the flange.

(Section *a* as amended was thereupon adopted.)

President Kittredge:—We will now take up section *b*, relating to vertical curves.

Mr. Cushing:—I move the section be adopted.

(Seconded by Mr. Carothers.)

Prof. Allen:—There are two methods of laying out vertical curves. The first method given here seems to be all right, but there seems to be a slight inaccuracy in the second method. Vertical curves should be either circular curves or parabolic curves. Under the conditions that prevail a parabolic curve is easier to handle than a circular curve, and practically there will be no difference between them. For a parabolic curve, it is true that in changing to the first chord the rate of change should be only one-half of that which prevails in passing from the first chord to the second, and from the second to the third, and so on throughout the curve, except at the end. The transition to the first chord from the first straight grade, and the transition from the last chord to the straight grade, should each be only one-half as large as the transition between the chords through the middle of the curve. The curve described here is defective as to this, with the result that in passing from the straight grade to the vertical curve, the transition is more abrupt than elsewhere on the curve. We put in horizontal transition curves for the especial purpose of making the transition more gradual. This curve has the defect of making the transition more abrupt at the start and at the end, and is, therefore, defective, and in my judgment the Association ought not to recommend it. To bring the matter before the Association, I move as an amendment that the matter beginning, "the following is another method which is recommended as of equal accuracy," etc., be omitted.

Mr. Poland:—The method which has been criticised is not theoretically correct, and the objection which is raised to it is perfectly correct and proper. The method is only given because it is a very neat and easy way of running in a curve in the field. It would be a very good way of staking grades in construction work, where, even if it varied one-tenth, it would not matter materially. The real error in using the method would amount to two or three-hundredths at the end of the curve. It would be an error in the wrong direction, but it would be a very unimportant one, as all of us know who have checked over the level of a piece of old track; that is, that the variation, even on a piece of very uniform track, is usually several hundredths in a few hundred feet. It would probably be better to cut it out, unless it is modified and a statement made that it is for approximate use only.

(The motion to strike out the section prevailed.)

Prof. Allen:—It is stated that "the proper length of vertical curves depends on the difference in rate of grade of the intersecting tangents. As a rule, we recommend that such curves should not be less than 200 feet nor more than 800 feet long." I have no objection to that statement. I think it is all right. I do wish to raise a point—that to me, at least, it is very difficult to determine any real, substantial, effective basis that fixes the length of a vertical curve. We are following precedent practically in that matter, and are doing very well; but supposing there is a point somewhere on the line where it seems necessary to economize as closely as possible in a vertical curve? I was recently asked to pass on a point of that sort, where there was great necessity for saving room, and the question came up: What is there that fixes the length? What are the practical considerations? Wellington gives a practical consideration which depends on the "grade of repose" between the engine and the last car of the train, the result, however, being a curve so long that it becomes substantially absurd, or, to put it in another way, entirely out of the question. It is not desirable to take the time of the Association now to discuss this matter, but it might be possible, at the proper time later, at the next meeting, perhaps, to have something practical brought out as to the real features that control the length of a vertical curve. I have given some thought

to it, but without very great satisfaction. I suggest this as something that others might be glad to know about.

(On motion, paragraph *b* was adopted as amended.)

President Kittredge:—The next subdivision of this report is *c*, relating to the "Proper Methods of Tamping." What is the pleasure of the Association in regard to these various paragraphs, six in number?

Mr. Abbott:—I move that section *c*, on the proper methods of tamping, be accepted as a whole.

President Kittredge:—Gentlemen, the subject is before you for discussion.

Mr. Abbott:—While I move the adoption of this section, there are two points in it which I think are contrary to my experience. Under the heading of "Earth Tamping," it says: "Tamp center of ties loosely with the blade of a shovel." In relation to earth tamping, I think that is true. But my experience in the South, where we have to tamp the ties to hold them, is that it is necessary to tamp all around and also get a shoulder; but under the head of gravel the same expression is used: "After train has passed, the center of tie shall be loosely tamped with the blade of the shovel." I started out on that practice, in the use of gravel ballast, but finally had to abandon it. It made a center-bound track in spite of the solid tamping at the end and just within the side of the tie. If the gravel was tamped the least, the train, by its weight, would ultimately bring down the whole tie until the center rose. On the gravel-tamped ties our practice is to put no more in the center of the tie than can be thrown in. The ends of the ties and 13 inches inside the rail are tamped. The center is left without any tamping, and the water washes in all that is necessary to be washed in between the ties, and I heartily recommend this statement to the Committee. If the gravel is thrown in there, so as to fill it fully at the center, you ultimately have a center-bound track, and the track, when the train passes over the ends of the tie, will spring like a spring-board.

Mr. Lum:—I suggest when tamping the track the ties be tamped at the joints last.

Mr. C. Dougherty (Illinois Central):—I would like to take exception to the statement with regard to broken stone ballast

in paragraph 4. I think the center of the tie should not be tamped at all—not even loosely. I would say not to tamp the center of the tie at all. It is sufficient to simply fill in under the center of the tie with the shovel without tamping.

President Kittredge:—Do you offer as an amendment that the words, “tamp center of tie loosely,” be eliminated?

Mr. Dougherty:—I offer that as an amendment.

President Kittredge:—It would seem, if it is well to leave out the question of tamping loosely, it would be well to say that the tie should not be tamped at all in the center.

Mr. Abbott:—I think if these words are substituted in this section, they should also be substituted in the section relating to earth or clay ballast. For the sake of harmony, it would not do any harm to add the same words in the other clause, that the center of the ties shall not be tamped at all.

Mr. Hart:—I ask for what reason the Committee specifies that the tamping pick be recommended instead of the tamping bar in ordinary practice?

Mr. Poland:—In the opinion of the Committee the tamping pick is a more satisfactory tool for ordinary practice than the tamping bar. With the ordinary man, if he is given a pick, he has to raise it up, and the pick itself will do some work when it comes down. It is not always sure you will get that with the tamping bar. The tamping bar, if it is scientifically used, I think will give equally good, and possibly better, results than the tamping pick, because it can be manipulated a little better, and possibly a man with the same expenditure of physical energy can do more work with it if he will, but for the ordinary section force, the belief of the Committee is that you will get more actual work, under ordinary practice, from the ordinary men with picks, than you will with bars, and that seems to be the consensus of the replies which were received by your Committee.

Mr. C. B. Hoyt (New York, Chicago & St. Louis):—I will state that in the past three years we have got more out of the tamping bar than out of the pick. It seems to meet with the approval of the men who handle it to a greater extent. I do not know what the experience of others is.

(Paragraph c, of section 2, was then adopted as amended.)

President Kittredge:—We will now take up section 3 of

the report, relating to Maintenance of Gauge, and consider paragraph *a*, relating to the proper method of spiking. What disposition will you make of this paragraph?

Mr. McDonald:—I move its adoption.

Mr. Churchill:—We are getting down now to the question of a great many tools, and I do not know what the sense of this meeting will be on this point, but I would like to find it out. There are many questions as to the details of tools. Take the first item, "The gauge shall be a wooden bar with circular metal arcs fastened rigidly to it for gauging surfaces." A great many roads are using metal bars. I think it is immaterial as long as they are correct, and as long as they are tested by a check gauge which railroad companies are using. If you get the correct gauge, it makes no difference whether you use wood or iron. I prefer iron. There are many similar things in these details. It seems to me we are not only taking up a great deal of time in the meeting, but we are possibly voting on something we may not want to follow. Why not approve the work of this Committee as a whole and lay it over for future discussion, to be adopted at a later meeting? Do we want to put ourselves on record as saying we shall use all these things? I have submitted to the adoption of many things different from my practice, and I know other gentlemen here are in the same position. Even though I submit to it, I do not want to say what I have been doing is wrong, and I do not think the others are ready to admit they have been wrong. What I want to bring up is, that there is a good deal of difference of opinion on these small matters, and that perhaps as an Association it would not be wise at this early date, the first time that these matters have been put in print, to adopt as a whole all these recommendations. Why should we not hold it over, approve the Committee's work as an excellent report, and let these details go over to another meeting? I make that as a motion.

President Kittredge:—The question raised by Mr. Churchill is a pertinent one, and I trust we shall hear from the members freely on the subject.

Mr. Cushing:—As long as Mr. Churchill has brought up the subject, I will say that I think there is something we have not fully settled yet, after our three years of experience, and that is, the proper method of handling this work. We have been

attempting to do too much in each individual report, more than we could do justice to in the meetings, and while the reports presented at this meeting are far superior to those at the last meeting in that respect, I do not believe we have gone far enough. I believe there should be a fuller discussion by the Committee on certain matters, so that they can be settled by degrees. My idea of a matter like this report, in order to bring about practical results, would be this: That the outcome of this work should be the compilation of a small book on maintenance-of-way work, containing these recommendations and standards, very much after the manner of the book of train rules in use in the transportation department on railroads, very much after the style of the book which has recently been published by the Southern Pacific and possibly other roads. But we cannot make that book all at once. We must make it by degrees and by adding small details. These details should be worked out in sufficient minuteness, so that there will be hardly any more to be said on them. This may take a long time, but we can settle all the points and matters which should go into this book, and that is really the object of our work—to give us something that is of use, and subject to modification from time to time, that we can readily refer to. I am very much in favor of making the report that deals with individual matters more full, and not attempt to deal with too many subjects at the same time, as has been the case with a good many of our reports.

Mr. McDonald:—I ask if it is not recognized that these details have finally to be acted on by this convention. If we put it off till next year, the same question will come up. We shall finally have to decide these questions, and I would like to hear suggestions as to how we can shorten our work.

Prof. Allen:—Would it not be a proper procedure for the meeting to consider the reports generally at the succeeding meeting? For instance, at the next meeting, to consider all the reports that are presented this year, and if there are matters which have escaped attention, we could have a discussion on these matters after we have had time to look over the report. It seems to me it would add to the value of what we do at these meetings if it were considered regular procedure to discuss each year the reports of the year before. In many of the railroad clubs it is cus-

tomary to discuss at each meeting the paper presented at the previous meeting, and it seems to me there is a great deal of profit in working that way.

Mr. McDonald:—I move that the consideration of this report be postponed until next year, so that when it comes up at that time it may be adopted as a whole.

President Kittredge:—There is already a motion, made by Mr. Churchill, that the further discussion of this report be postponed until next year.

Mr. McDonald:—We will have time between now and the next meeting to thoroughly digest this report and find what objection we have to it. We ought then to be able to dispose of it in a short while and have some preliminary discussion on the Committee's report to be presented at the following meeting. If that seems to be the proper method to pursue, to present the reports at one meeting and adopt them at the next, I am heartily in favor of it.

Mr. Churchill:—I accept the amendment, it being understood that written discussions be sent in during the year. The Committee may want to make use of these discussions and amend its report next year.

Mr. B. Douglas (Michigan Central):—I suggest that these reports, instead of being made to the Association, be made to the Board of Direction, and the Board insist that they be made some time in advance, the Board to select certain topics for discussion at the convention. There are too many reports to discuss at present in the time we have at our disposal.

President Kittredge:—It has been a matter of grave concern to the Board of Direction to get these reports in what they considered proper shape. They started out with the idea that all reports should be in the hands of the Board of Direction not later than January 15. This report reached the Board of Direction March 6, and only one of the reports was received before the first of March. It was not owing to any lack of interest or effort on the part of the Board of Direction that they were not received. There were many reasons that operated to delay the reports, some entirely unavoidable, and others, perhaps, were not so good. The past year has been a particularly busy one for all who have had anything to do with maintenance, and it has been hard to get action by committees the members of which were

situated in different sections of the country. We have made an improvement over what we have had before. We have, in getting one report early, succeeded in doing better than we ever did before. We hope to do better the next time. Some of the chairmen of the committees, at very late dates, had to resign for good and sufficient reasons, and other gentlemen were appointed in their places. We have got to make progress in some way, and it is for the Association to say just how the matter shall be handled. We must at some time thresh these questions out and carry them down to a conclusion. The members will all agree that the longer the time they can have to think over and digest the reports, the better it will be; but the practical question of getting the reports on time is a difficult one, and one which the Board of Direction have found themselves powerless to insist upon.

Mr. McDonald:—It has been suggested that the Committee has already entirely covered every subject connected with the track; that they have exhausted the matter so far as the subjects they would have to consider are concerned, and it would seem there would be little to report at the next meeting, unless we postpone till next year the remainder of the report now presented. It would, perhaps, be as well to do this, and for those members who have anything to say on the subject to communicate with the Committee during the year and let them consider these matters and present their report next year for final adoption.

President Kittredge:—Is there any further discussion on the amendment to accept the report of the Committee and postpone the discussion of the items not acted upon until next year, the members of the Association in the meantime to send in such communications to the Committee bearing on the report as they desire?

Mr. McDonald:—And that the Committee be permitted to amend their report as they see fit after this discussion is received.

Mr. A. W. Johnston (New York, Chicago & St. Louis):—The Committee states to the Association that it has not acted on five subjects out of ten assigned to it by the Board of Direction. It occurs to me that we do not want to leave the Committee in the dark as to the real intent of the motion which has been made with respect to their work for the next year. If we simply refer this report back to them, with a request to our members to communicate to them such criticisms or amend-

ments as may occur to them during the year, they might come back to us with this report only. It seems to me that it should be left open to such line of action as they may deem best with respect to the whole scope of the work laid down for them by the Board of Direction.

Mr. Cushing:—The trouble is we have too much before us, and so far as the disposition of the report is concerned, this report, taken as it is now, will not be disposed of any quicker next year than this year. The whole point is whether we are trying to handle too many things in one report, or whether we are asking too many committees to report at one meeting. It may be that each committee should make a report of smaller scope, and perhaps in more detail in the particular scope which is selected, and hear from all the committees, or it may be best to have such reports as this, covering a great deal of ground, and hear from fewer committees.

President Kittredge:—The amendment, if passed, will really supersede the original motion, and will be to the effect that the part of the report which has not been discussed will be accepted as a report and returned to the Committee; the details of the report to be discussed by mail by the members, and the Committee to so modify and amend the present report as it seems to them proper, after having received the discussion and criticisms. Am I right in getting that intelligently before the house?

(The amendment was carried.)

President Kittredge:—The next report to be considered is that of the Committee on Ties. The Secretary will read the names of the Committee, and they will please take seats on the platform. If you will give your attention, you will hear what the vice-chairman of the Committee has to say.

### REPORT OF COMMITTEE No. III.—ON TIES.

*To the American Railway Engineering and Maintenance-of-Way Association:*

It is not the intention of the Committee to endeavor to present at each meeting a memorial attempting to cover the whole tie question, but to discuss certain questions relating to it, which will be carefully studied before presentation. Sometimes it will be one phase of the subject, and sometimes another. Two studies which will be practically continuous in interest and importance are "Timber Supply and Culture," and "Timber

Preservation," meaning, of course, their relation to cross-ties, and these have been touched upon in the present report. Statistical information, too, is very important to enable us to draw conclusions, and, of course, benefit ourselves thereby. Therefore we have continued to report such information in that line as has been sent us, but we have not attempted to analyze the results in much detail, because we have not yet had our forms for collecting the information approved by the Association.

Cross-tie specifications are being studied with a view to making recommendations to the Association at a future date.

### TIMBER SUPPLY.

A study of the tie question would naturally start with the possible supply in the country; but this is a subject so vast and one on which so much data is absolutely necessary to anything like an exact conclusion, that the Committee felt indisposed to touch it. However, the vastness of the supply has not been as much in evidence of late, as an apparent shortage, resulting in changes in character of tie material and the sources from whence it is drawn; and it was deemed best to make some tentative effort to secure light on the subject. If the result is nothing more than to show the necessity for a thorough and complete investigation by the Forestry Department of the Government, it will be well worth the cost.

The Committee prepared a circular letter, with an enclosed postal, copies of which were sent to all members, asking the following questions:

1. What material do you now use for ties, and how many annually renewed?
2. Have you modified your specifications as to character and quality during the last ten years, and are they more or less stringent?
3. Have you changed the sources of your supply?
4. What percentage of tie renewals come from foreign lines, if any, and kind of wood?
5. How many years' supply of the tie now used do you estimate is left along your own line?
6. What kinds of inferior woods are still left in country tributary to your line, and, at present rate of consumption, how long would such supply last?

A very general and gratifying response came to the circular. Replies were received from about 80 roads, representing a mileage of 70,000.

It was the intention to ask questions which members could answer from general knowledge, expecting that from these general answers, by comparison, fairly correct conclusions as to the general facts could be drawn. The questions as to the supplies of timber remaining are, of course and avowedly, estimates.

The replies indicate that generally there has been no change, or but very little, in the specifications under which ties are bought. One-third of the replies to the third question were in the affirmative, and two-thirds in the negative. The replies in detail are given in a table on file in the office of the Association, where members who desire to examine it will find it. It hardly seemed desirable to publish the information in detail. The

figures have been carefully studied and the facts summarized are as follows:

Of the roads reporting, there are 18, representing a mileage of 17,500, which now secure all their ties of the kind now used from along their own lines, and which have a supply in sight for the next ten years. Of this mileage, on one-half pine ties are the standard.

Five roads, with 4,500 mileage, have in the past been able to supply all their own needs, but can continue to do so for less than ten years.

Seven roads, with 7,100 mileage, can supply less than all, but 50 per cent or more, of their own needs for from two to three years on indefinitely.

Eleven roads, mileage 19,000, can furnish more than 10 per cent, but less than 50 per cent.

Twenty-one roads, mileage 14,500, can supply none or less than 10 per cent.

As regards supplies of inferior woods, there were 13 roads, mileage 8,000, reporting none available. All the rest reported supplies sufficient for from three to thirty years.

Geographically considered, the figures above are based on replies received representing a mileage of 13,000 in Eastern Canada, the New England and Middle States; 10,000 in Southern Atlantic; 33,000 in the Middle West and Southern States; 6,600 in the Western States.

Besides the roads represented in the figures above, reports were received from the Southern Pacific, Atchison, Topeka & Santa Fe, and the Colorado & Southern. The first two roads are already using treated ties very largely and consequently using inferior timbers; and it did not seem best to include them in the summarizations. The Atchison, Topeka & Santa Fe Railway reported that they had changed their source of supply during the past two years, in that while they formerly used oak ties for their lines in Kansas, Illinois and Iowa, they are now using treated pine ties; and in consequence of the treatment they did not rate as inferior woods those materials which are usually so considered.

The Colorado & Southern reported that they will change this season from untreated mountain pine, from which they derive a life of only three years, to the same material treated, which will be used exclusively.

It has not seemed best to the Committee to attempt to draw conclusions from the figures secured, leaving that for individual members to do. A number of replies from roads reporting large supplies of timber for their future use have qualified their statement with the clause, "if shipments from off our lines are prohibited." Another element in the West which may affect the condition is the possibility of the Government setting aside additional forest reserves, which will, to that extent, cut down the available supplies.

#### PRESERVING METHODS.

Having issued a number of blanks for statistics, the Tie Committee deems it desirable that the results obtained with treated ties should be recorded year by year. Perhaps experience is still too recent in this

country, and the treatment is being so improved that conclusions cannot yet be drawn as to the absolute average life, which is the important thing to know, but something may be learned from the ties treated since 1885, and something also from trial lots, the latter, however, being less conclusive than averages derived from results upon a whole line of road, when its records admit of this being arrived at.\*

A review of what American railroads have done since 1885 towards tie preservation was given in the last report. Since then the Atchison, Topeka & Santa Fe Railway has compiled a record in detail of treated pine ties which shows the following:

Removed in 1897 on 7 divisions, average life.....10.70 years  
 Removed in 1898 on 7 divisions, average life.....11.06 years  
 Removed in 1899 on 7 divisions, average life.....11.11 years  
 Removed in 1900 on 7 divisions, average life.....11.28 years

Most of the ties had been laid on two divisions, and these (the Rio Grande and the New Mexico divisions), which have the least rainfall, show the longest average life.

Before deciding to treat its ties, the Atchison, Topeka & Santa Fe Railway tried preliminary experiments in 1881, by having some ties of various kinds of perishable timber treated by Mr. J. P. Card at St. Louis. These were laid at Topeka, Kan., and at La Junta, Colo., with the following results:

AT TOPEKA, KANSAS.				APRIL 9th, 1891.			March 6th, 1893.		
Lot.	Kind of Wood.	No. of Ties.	Date Laid.	No. in Track.	% in Track.	Years Laid.	No. in Track.	% in Track.	Years Laid.
1	Colorado Pine.	49	July 7, 1881	Destroyed	by a wreck.	.....	.....	.....	.....
6	Cottonwood...	87	Aug. 1, 1882	43	49.4	8.69	10	11.5	11.58
7	Sweet Gum...	51	" 1882	10	19.6	8.69	.....	.....	.....
8	Red Oak....	48	" 18, 1882	29	60.2	8.64	1	2.1	11.50

A change of Roadmaster has left this record incomplete.

AT LA JUNTA, COLORADO.				July 6, '91		May 11, '93		Mar. 14, '97		Jan. 3, '01	
Lot.	Kind of Wood.	No. of Ties.	Date Laid.	No. in Track.	Years Laid.	No. in Track.	Years Laid.	No. in Track.	Years Laid.	No. in Track.	Years Laid.
1	Black Oak.....	49	May, 1882	49	9.1	47	11.	44	14.8	.....	.....
2	White Cotton.....	49	" 1882	47	9.1	11	11.	8	14.8	6	18.6
3	Cottonwood.....	50	" 1882	46	9.1	22	11.	7	14.8	.....	.....
9	Colorado Pine.....	50	July, 1881	50	10.	20	11.8	.....	.....	.....	.....

Some of the figures are the result of examinations by Mr. Chanute.

\* Special lots may have been specially treated, or may contain more or less than an average of "sick ties." In Europe a discount of 5 per cent is claimed by guaranteeing contractors to cover ties whose hidden defects cannot be discovered by inspection.



Treated In.	Pennsylvania Company.	P., C., C. & St. L. Ry.
1897	25,529 Hemlock Ties.....	
1897	169 Tamarack Ties.....	
1897	780 Black Oak Ties.....	
1898	.....	13,244 Red and Black Oak Ties.
1898	.....	11,177 Beech Ties.
1899	3,843 Hemlock Ties.....	1,575 Red and Black Oak Ties.
1899	.....	23,614 Beech Ties.
1900	7,147 Red and Black Oak Ties..	27,000 " "
1901	16,716 Beech Ties.....	25,165 " "
1901	26 Red Oak Ties.....	

These ties have yet had too brief an exposure to inquire into the results, but they are here on record to serve an inquiry into the average life of these various kinds of treated wood hereafter. This road, however, inaugurated an experiment in 1892, by laying 200 Hemlock and 200 Tamarack ties, treated by the zinc-tannin process, alongside of an equal number of untreated White Oak ties. The results up to July 3, 1901 (9 years), were as follows:

Hanna Station—Stone ballast, Hemlock renewed....	25 per cent.
Hanna Station—Stone ballast, White Oak renewed....	40 per cent.
Kosciusko Station—Gravel ballast, Tamarack renewed .....	78.5 per cent.
Kosciusko Station—Gravel ballast, White Oak renewed .....	50.1 per cent.

Indicating that Hemlock is preferable to Tamarack for treatment and that stone ballast is preferable to gravel ballast for treated ties.

The Chicago & Eastern Illinois Railroad, the Chicago, Burlington & Quincy Railroad, the Great Northern Railway, the Missouri, Kansas & Texas Railway, and some other lines, are also having ties treated; but their experience is yet too recent to be put on record at this time.

There was a small experiment on the Duluth & Iron Range Railroad, inaugurated in 1890, which is worth recording, the ties having been shifted when lowering the track.

#### RECORD OF DULUTH & IRON RANGE RAILROAD.

No. Ties.	Kind of Wood.	Date Laid	1895.	1896.	1898.	Nov. 30, '01		Remarks.
						In Track.	Years.	
85	White Pine..	Nov. 1890	Track torn up with dynamite.	Almost all relaid.	All in reported sound.	45	11	Said to be good for 6 or 7 years more.
85	Tamarack...					68	11	
86	Norway Pine					79	11	

Too much stress cannot be laid upon the importance of keeping full records; not only in the track but of the treatment at the works, to serve as

a basis for future improvement of processes, or of change of process, for plants can easily be altered. Better economical results will thus be obtained, although, perhaps, at greater first cost.

Ties last much longer abroad than they do in the United States. An inquiry into European methods and results of tie preservation has been carried on since 1892 by Mr. V. Herzenstein, Civil Engineer, of St. Petersburg, Russia, who was appointed Reporter thereon by the International Commission of the Railway Congress. An elaborate report was submitted to the meeting of September 25, 1900, which is published in the Bulletin of the International Railway Congress for July, 1901. The gist of the whole report is fairly summed up in the following quotations from page 1483:

"The managements which pickle their sleepers recognize, as we have already stated, that the best process, as far as the life of the sleeper is concerned, is creosoting (or the Blyth process properly carried out); but they all mention that it is necessary to use a heavy oil (crude creosote) which is rich in antiseptic substances, such as carbolic acid, naphthalene, etc. Several managements (Russian lines) express the opinion that the treatment with zinc-chloride is the cheapest process for insuring that fir and pine sleepers should have a reasonable length of life.

"The French State Railway and several other Railways prefer to pickle sleepers with an emulsion of zinc-chloride solution and creosote; this process seems to have a future before it, particularly in the case of sap wood, which is very absorbent.

"The information supplied by the different managements show that the best process on the whole is creosoting; the average life (which we may perhaps fairly consider as the average life for all railways) of creosoted sleepers amounts to:

Creosoted Pine, on main line 15 years, on sidings 5 years. Total 20 years.

Creosoted Oak, on main line 18 years, on sidings 7 years. Total 25 years.

Creosoted Beech, on main line 20 years, on sidings 10 years. Total 30 years.

"This shows that beech is a very good wood for sleepers and that we are justified in considering the beech sleeper as the sleeper of the future."

An examination of the individual reports of the railways tabulated shows that a number of them have failed to realize the above quoted average life with creosote, and that the best results coincide with the highest cost of treatment. Where timber is still comparatively cheap, inferior processes will be resorted to. For the zinc-chloride treatment one Prussian road reports 15 years average life for treated pine, one Austrian road reports 12 to 16 years, and another 19.6 years; one Danish road reports 12 years, and the Dutch Railway Company reports 15 years. All of these are for pine. The average lives show better for oak and worse for beech than the above. The Russian roads, who took up the process later, seem to have obtained very inferior results. One road reports 8 years, another 7

years, and a third 10 years as the average life of pine treated with zinc-chloride. Many of the Russian roads using the process omit to state the results, possibly because their experience is too recent. Ties in that country are still cheap, pine sleepers being reported by various lines as costing, untreated, from 12.4 to 44.2 cents each, and oak ties from 36.2 to 64.8 cents each.

Mr. Herzenstein calls attention in other parts of his report to the Rütgers or zinc-creosote process as likely to prove effective for cheap ties. The Imperial Prussian Railways, which have had the longest experience with this process, did not answer his circulars. Four other roads did, but do not state the average life. The French State Railway, however, estimates that zinc-creosote preserves the sleepers about 25 per cent longer than straight zinc-chloride.

In a discussion of tie preservation by the French Society of Civil Engineers in July, 1901, it was stated by a member, who advocated straight creosoting, that he had made an examination during the preceding month of 17,375 sleepers treated with zinc-creosote by Rütgers and laid in 1888. Some 84 per cent were yet in the track after 13 years' exposure, while of a lot treated by another contractor by the same process (nominally) no less than 50 per cent were rotten after an exposure of 6 years.

It is understood that one of the plants in the United States is about to experiment with the zinc-creosote process; having succeeded, after a year's delay, in procuring suitable tar-oil.

One tie-treating plant has been shut down, one has been moved, and two have been built in the United States during 1901. They now stand as follows:

Location.	Year built.	Owner.	Process.	Kind of Wood.	No. Retorts	Est'd Capacity Ties per Annum.
Lowell, Mass. ....	1848	Locks & Canal Co. ....	Kyanizing ....	Various ...	2	30,000
Las Vegas, N. M. ....	1885	A. T. & S. Fe Ry. ....	Zinc-Chloride.	Pine. ....	3	500,000
Bellemont, Ariz. ....	1898	" ..	" ..	" ..	1	350,000
Chicago, Ill. ....	1886	Chl. Tie Preserving Co.	Zinc-Tannin ..	Hemlock ..	4	500,000
Mt. Vernon, Ill. ....	1899	" ..	" ..	Black Oak ..	1	200,000
Somerville, Tex. ....	1897	Tex. Tie & Lumber Co.	" ..	Pine, etc. ..	6	2,000,000
Kallispell, Mont. ....	1901	Gt. Northern Ry. ....	" ..	Pine Fir. ...	4	1,200,000
Houston, Tex. ....	1891	So. Pacific Co. ....	Burnettizing ..	" ..	5	1,500,000
Greenville, Tex. ....	1901	Mo., Kan. & Tex. Ry.	Zinc-Tannin ..	Pine Gum. ...	3	900,000
Calif. and Oregon. ....	1894	So. Pacific Co. ....	Burnettizing ..	Pine Fir. ...	2	1,000,000
Oakland, Cal. ....	1889	" ..	Creosoting ..	Pine, etc. ...	2	1,000,000
Sheridan, Wyo. ....	1899	C. B. & Q. Ry. ....	Burnettizing ..	" ..	2	500,000
Beaumont, Tex. ....	1897	Intl. Creo. & Cons. Co.	Various. ....	" ..	1	500,000
Perth Amboy, N. J. ....	1900	U. S. Wood Preserv- ing Co. ....	Creo. Resin. ...	" ..	4	1,200,000
Brooklyn, N. Y. ....	1878	Eppinger & Russell. ....	Creosoting ....	" ..	4	800,000
Norfolk, Va. ....	1896	Nor. Creosoting Co. ....	" ..	" ..	4	900,000
W. Pascagoula, La. ....	1876	L. & N. R. R. ....	" ..	" ..	2	400,000

Under the auspices of the United States Department of Agriculture an experiment has been inaugurated in 1901 to test the relative merits of different methods of treating ties of various kinds of timber. For this purpose the following railroads and individuals have donated ties as follows:

Donated by	Number and Kind.
A., T. & S. Fe Ry....	800 long leaf, 500 short leaf, 800 loblolly and 350 Red Oak.
C., R. I. & P. Ry....	500 Hemlock.
Pennsylvania Co....	500 Beech and 500 Black Oak.
Mo. Pacific Ry.....	200 White Oak.
Ill. Central R. R.....	500
Cotton Belt Route....	300 White Oak.
Wm. Ripley & Son...	400 Tamarack.
Ayer & Lord....	500 Red, Black, Turkey, Spanish and Willow Oak.

A total of 5,850 ties, and perhaps more coming.

Of these some 4,900 have been treated gratis at Chicago, at Somerville, Texas, and at Beaumont, Texas, by the zinc-tannin, the zinc-chloride, the Allardyce and the Hasselmann processes; also with Beaumont petroleum and zinc-chloride, with carbolite and with Spiritine. The most noxious place which could be found has been selected, about seventy-five miles east of Somerville, on the Montgomery Branch of the Gulf, Colorado & Santa Fe Railway in Texas, at a spot where unprepared pine ties generally decay in 12 to 14 months, and where, in consequence of the bad drainage, heavy rainfall and warm temperature ties treated with zinc-chloride have decayed in 2 to 4 years. The results are to be watched and reported upon year by year by the special agents of the Bureau of Forestry, Department of Agriculture. Messrs. Hermann von Schrenk and Gellert Alleman are the special agents who have managed the arrangement and the duly marking of these experimental ties with dating and identification nails. They have furnished a copy of the records thereof which has been filed with the Secretary of the American Railway Engineering and Maintenance-of-Way Association for the benefit of its members who may wish to examine these ties. The results, of course, will be comparative only, and not absolute.

The method adopted for marking these experimental ties will be of interest to the members, and we therefore present the scheme below:

B U Signifies Burnett Process	B A Signifies Barshall Process
W E " Wellhouse Process	<del>W E</del> " Chanute Treatment
A L " Allardyce Process	<del>A L</del> <del>W E</del> " Byrnes Treatment

In addition to the nails indicating the treatment to which the ties are subjected, the following dies indicate the woods used:

H Signifies Hemlock	W Signifies White Oak
L " Long-leaf Pine	T " Tamarack
L L " Loblolly	S O " Spanish or Water Oak
S " Short Leaf Pine	Y B " Yellow But
R H " Red Heart	R O " Red Oak
B " Beech	W O " Willow Oak
B O " Black Oak	

Each tie is marked by three zinc-coated wire nails, which indicate the date, kind of wood, and the treatment. In the case of a few ties, which have been treated by Mr. Chanute and Mr. Byrnes by approximately respective treatments, such as used at Somerville, those treated by Mr. Chanute have been marked by a fourth nail, stamped  $\times$ ; while those treated according to the Allardyce process by Mr. Byrnes at Beaumont are marked by a nail stamped  $\times \times$ .

Prof. Hermann von Schrenk visited Europe in the summer of 1901 to investigate timber preservation and has made an elaborate report to the United States Department of Agriculture.

The choice at present lies between these various processes:

1. Creosoting—Injection of heavy tar-oil, rich in antiseptics.
2. Creo-resinate process—Creosote, resin and formaldehyde.
3. Water-creosote process—Emulsion of creosote and water.
4. Kyanizing—Injection of corrosive sublimate.
5. Burnettizing—Injection of chloride of zinc alone.
6. Zinc-tannin—Chloride of zinc, followed by glue and by tannin.
7. Zinc-creosote—Emulsion of chloride of zinc and creosote.
8. Allardyce process—Injection of chloride of zinc, followed by creosote.
9. Hasselmann process—Boiling in sulphates of iron, copper, etc.

Perhaps there will be data for more of the above and other new processes for future reports. Now that the American railroads are beginning to treat their ties we may expect a new crop of suggestions and processes. It may be well to experiment on a small scale with the more plausible of them, so that five or ten years hence we can judge of the probable results. Especially is this the case with petroleum, a home product, some varieties of which are now very cheap. It is not an antiseptic, but possibly may be rendered so by the addition of other substances. It is understood that the Russian chemists have been endeavoring to do so, but have not made a success as yet.

### STATISTICS.

Many of the members are yet unable to furnish statistics relative to cross-ties, but it is hoped that in course of time there will be new recruits, and that all will be keeping their records on the same basis. Blanks were sent by the Secretary to 187 members, and answers were received from 53, or 28 per cent. Of the replies, fourteen, or 26 per cent, stated that no information could be given for lack of proper records; 39, or 73 per cent, filled in Form I, 11, or 20 per cent, Form I-A, while only one member filled in I-B, and four I-C.

One of the first duties of the Association in connection with this subject is to decide what will be the "Association" standard form of blanks for keeping cross-tie records, so that the information will be presented in the same manner each year. There was some criticism last year of the blanks, and one blank was so ambiguous that only one road filled it

in correctly. Some of the others were of such form that they had to be split in two parts for tabulation of more than one road in the report. Therefore, your Committee has made some changes in the blanks in order to correct the former errors, and if they are yet unsatisfactory, the members should criticise them, and offer practical improvements. Then, as the personnel of the Committee changes from time to time, it will not be necessary to keep changing the blanks. Otherwise the members who have begun to keep records according to the suggestions of the Committee, will become discouraged and give it up.

Moreover, the blanks should have some relation with each other, as it is impossible to put all the different kinds of information relating to cross-ties in one table. The scheme of the blanks submitted with this report will therefore be outlined as follows:

*Form 1* is intended for general statistical information concerning the life and cost of cross-ties in use on a division, regardless of the kinds of timber, except in a general way.

*Form 1-A* is a more detailed comparison between the different kinds of woods and preservative processes, and will explain, in many cases, why the service of ties on one railroad is longer than on another. The blank has been prepared in such a way that it will be unnecessary to split it up for tabulation and printing, as was done last year. It is, therefore, more convenient for examination.

*Form 1-B* is the life record of ties, and must be printed separately for each road. It was split up last year so that it meant nothing. Only the Southern Pacific System is able at the present time to furnish valuable information for it, but the Committee recommends that the other members begin to prepare for such a record. The form sent out by the Committee is reversed from the form of the Southern Pacific Company, because columns for "Main" and "Side" Tracks separately were introduced. As no information for these separately was given, the percentages were introduced in one column instead, when the report was printed.

The Southern Pacific Company has also furnished detailed information concerning the "cause of removal" of treated ties which the Committee has presented in Table V, page 14.

*Form 1-C* is a new blank which is intended to give full details concerning the preservation of cross-ties, and has been prepared after consulting the report of the Reporter on ties to the last International Congress of Railroads.

*Form 1-D* is printed as a suggestion to the members of the proper blank to be used by the section foreman for reporting the information required for Form 1-B. This Form can also be used for reporting any cross-tie removals when the ties are marked in such a way as to indicate the year laid. (See page 105.)

Respectfully submitted,

E. B. CUSHING, E. M. W., Sou. Pac. Atl. Sys., Houston, Tex., *Chairman*;  
W. C. CUSHING, Supt., Penna. Lines West, Allegheny, Pa., *Vice-Chairman*;  
O. CHANUTE, Consulting Engineer, Chicago, Ill.;  
W. W. CURTIS, Consulting Engineer, Chicago, Ill.;  
J. B. BERRY, Chief Engineer, Union Pacific R. R., Omaha, Neb.;  
WM. ARCHER, Prin. Asst. Eng., B. & O. S. W. R. R., Cincinnati, O.;  
C. C. MALLARD, Div. Eng., Sou. Pac. Co., Algiers, La.;  
E. E. HART, Engineer, N. Y. C. & St. L. Ry., Cleveland, O.;  
J. C. NELSON, Roadmaster, A. G. S. R. R., Birmingham, Ala.;

*Committee.*





TABLE V.—STATISTICS OF TREATED TIES.

RAILWAYS.	LIFE OF TREATED TIES IN YEARS.																AVERAGE COST PER TIE.																	
	PINE.		HEMLOCK.		BEECH.		SPRUCE.		REDWOOD.																									
	Name of Process.																Antiseptic Used.					Amount Injected Per Cubic Foot.		Number of Treated Ties in Track this date.		Number put in tracks this year.		First Cost Untreated.		For Extra Handling and Transportation.		For Preservative Treatment.		Ready for Track.
1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18	19	20	21	22	23	24	25	26	27	28	29	30					
New Orleans & Northeastern... }	Creosote.	Burnett-izing.	Zinc Tannin.		Creosote.	Burnett-izing.	Zinc Tannin.		Creosote.	Burnett-izing.	Zinc Tannin.		Creosote.	Burnett-izing.	Zinc Tannin.		Creosote.	Burnett-izing.	Zinc Tannin.		Creosote.	Burnett-izing.	Zinc Tannin.		Creosote.	Burnett-izing.	Zinc Tannin.		Creosote.	Burnett-izing.	Zinc Tannin.			
N. Y. C. & H. R. R. R. Eastern Division.	18 Yrs.																				Creosote.	13 lbs.	30,000	1,500	.90			.90	1.80	**				
Southern Pacific—Pacific System.																					Creosote.	10 lbs.	15,700	2,500					1.35	*				
Southern Pacific—Atlantic System.																					Creosote.	0.248 lbs. pure Zn. C.	4,357,489	4,381	.20	.1	.10	.40						
																					Creosote.	0.246 lbs.	2,300,435	273,635	.22	.05	.08	.35						

\*\*\*Ties are on 6-mile trestle. Replaced on account of rails cutting "gravel protection" into tie; now tie-plates.

The life record of treated flies should be kept by members separately on a blank like Form 1B.

TABLE VI.—SOUTHERN PACIFIC CO.—Atlantic System.

Cause of Removal of Burnettized Ties from Track during the year ending December 31, 1894 (by Districts).

	DISTRICTS.	No. Ties Removed	CAUSE OF REMOVAL.						Average Life.	
			Rotten.		Shiv'r'd-Br'k'n.		Accidents and Misc. No. Ties.	Per Cent.	Yrs.	Mos.
			No. Ties.	Per Cent.	No. Ties.	Per Cent.				
1894	Glidden .....	848	737	87	108	13	8	.....	5	8
	San Antonio .....	4,109	2,440	84	492	12	177	4	6	2
	Del Rio .....	123	70	57	53	43	.....	.....	5	5
	Sanderson .....	34	7	21	15	44	12	35	5	6
	Valentine .....	20	.....	.....	20	100	.....	.....	5	10
	El Paso .....	110	48	44	60	54	2	02	5	.....
	Total .....	5,244	4,362	82	743	14	199	4	6	0
1895	Glidden .....	841	660	81	161	19	.....	.....	6	5
	San Antonio .....	10,330	8,444	82	1,886	18	.....	.....	6	10
	Del Rio .....	2,504	1,850	71	735	29	9	.....	6	8
	Sanderson .....	25	21	60	14	40	.....	.....	5	11
	Valentine .....	137	66	48	30	22	41	30	5	7
	El Paso .....	2,667	270	10	1,600	60	797	30	6	3
	Total .....	16,604	11,331	68	4,426	27	847	5	6	8
1896	Glidden .....	1,871	1,502	85	279	15	.....	.....	5	11
	San Antonio .....	16,904	14,343	85	2,366	14	105	01	7	9
	Del Rio .....	4,398	3,951	90	417	10	30	.....	8	0
	Sanderson .....	297	116	39	71	24	110	37	4	8
	Valentine .....	1,065	903	85	162	15	.....	.....	7	3
	El Paso .....	4,426	3,115	70	741	16	570	14	6	9
	Total .....	28,961	24,020	83	4,066	14	875	08	7	6
6 Months ending June 30, 1897.	Glidden .....	1,750	1,535	88	215	12	.....	.....	7	5
	San Antonio .....	8,196	7,243	89	916	11	27	.....	8	2
	Del Rio .....	3,612	3,375	94	210	06	27	.....	8	8
	Sanderson .....	501	169	34	2	.....	330	06	6	1
	Valentine .....	3,453	2,783	81	619	18	51	01	6	11
	El Paso .....	1,963	1,710	86	70	04	203	10	7	3
	Total .....	19,485	16,815	86	2,032	10	638	04	7	10
1898	Glidden .....	3,637	3,625	100	12	.....	.....	.....	7	0
	San Antonio .....	19,966	18,344	92	1,584	08	58	.....	8	8
	Del Rio .....	8,420	7,673	91	727	09	30	.....	9	5
	Sanderson .....	2,858	2,127	74	101	04	630	22	7	5
	Valentine .....	10,456	8,685	83	1,379	13	392	04	7	0
	El Paso .....	7,945	6,979	87	836	11	130	02	8	2
	Total .....	53,302	47,433	89	4,639	09	1,230	02	8	3
1899	Glidden .....	1,632	1,629	100	3	.....	.....	.....	8	6
	San Antonio .....	23,340	22,416	96	869	4	55	.....	9	7
	Del Rio .....	14,227	13,179	93	1,025	7	23	.....	10	1
	Sanderson .....	8,062	7,487	92	455	6	140	2	9	1
	Valentine .....	10,180	9,642	95	263	2	275	3	8	5
	El Paso .....	14,028	12,809	91	1,089	8	130	1	8	7
	Total .....	71,489	67,162	94	3,704	5	623	1	9	3
1900	Glidden .....	1,287	1,268	99	19	1	.....	.....	11	5
	San Antonio .....	28,702	27,309	95	1,366	4	27	1	10	3
	Del Rio .....	15,827	14,464	91	1,256	8	107	1	10	5
	Sanderson .....	8,766	7,440	85	771	9	555	6	9	3
	Valentine .....	53,368	51,639	97	1,509	3	220	0	9	6
	El Paso .....	40,974	38,284	94	2,570	6	180	1	9	1
	Total .....	148,924	140,404	94	7,491	5	1,029	1	9	8
1901	Glidden .....	28	.....	.....	28	100	.....	.....	6	3
	San Antonio .....	35,698	32,646	91	1,077	3	1,975	1	10	1
	Del Rio .....	41,330	37,875	91	3,348	8	107	1	10	9
	Sanderson .....	29,336	27,293	93	1,115	4	928	3	10	2
	Valentine .....	3,840	3,025	78	527	12	288	10	8	6
	El Paso .....	31,380	28,226	90	1,954	6	1,200	4	10	2
	Total .....	141,612	129,065	91	8,049	5	4,496	4	10	3

**1901.**

June 30, 1898, 1899, 1900 and 1901.

DISTRICTS.	No. Ties Removed	CAUSE OF REMOVAL.						Average Life.	
		Rotten.		Shiv'r'd-Br'k'n.		Accidents and Misc. No. Ties.	Per Cent.		
		No. Ties.	Per Cent.	No. Ties.	Per Cent.			Yrs.	Mos.
Glidden.....	11,894	11,066	92	820	7	8	1	7	5
San Antonio .....	147,255	134,185	91	10,568	7	2,484	2	9	3
Del Rio .....	90,531	82,437	91	7,771	8	323	1	10	1
Sanderson .....	49,909	44,660	89	2,544	5	2,705	6	9	11
Valentine.....	82,519	75,743	93	4,509	5	1,267	2	8	9
El Paso .....	103,513	91,441	88	8,920	9	3,152	3	9	
Total .....	486,621	440,532	91	35,150	7	9,930	2	9	3

### SYSTEM.—YEARLY RENEWALS.

YEAR.	Miles Track Including Sidings.	No. Ties Renewed, All Kinds.	Per Cent Removal to Total in use.
1887	1,931.56	498,581	9.8
1888	1,946.86	589,969	11.5
1889	2,018.66	508,150	9.5
1890	2,025.22	410,153	7.5
1891	2,049.07	497,617	9.2
1892	2,063.18	495,287	8.8
1893	2,085.32	428,053	7.3
1894	2,128.65	365,393	6.1
1895	2,175.97	430,014	7.0
1896	2,192.87	431,628	7.0
1897*	2,198.28	232,460	3.8
1898	2,214.25	394,729	6.4
1899	2,274.32	467,776	7.3
1900	2,425.68	618,295	9.1
1901	2,606.57	576,572	8.2

\*For 6 months from January 1, to June 30, 1897.

**Form 1-D**

**AMERICAN RAILWAY ENGINEERING AND MAINTENANCE-  
OF-WAY ASSOCIATION.**

### Report of Treated Ties Removed from Tracks.

On Sec..... Subdivision..... During Month of.....190....

[illegible]

This blank must be sent in monthly by all Foremen on whose sections treated ties have been used, whether any ties have been removed or not. When no ties have been removed, it must be so stated on the blank.

After approval by the Supervisor it is to be forwarded to the Engineer Maintenance of Way (or other proper officer).

.....  
Foreman.

Mr. W. C. Cushing (Pennsylvania Lines) :—This is a report which, I am happy to say, I think can be disposed of quickly. The scope of this report presented to the Association this time consists as follows: First, a short article on timber supply, which is simply the beginning of a subject which it seems to the Committee is of vital importance, and which should be called to the attention of the Association each year; in other words, it is the province of the Committee to keep posted through the literature of the day on the subject of timber supply, so that the Association may be advised in regard to it. It is not what may be considered a detailed report of which the members have to signify their approval. It is simply a statement of what has been gathered so far relating to that subject.

The same thing is true of the part of the report relating to preserving methods. It is the object of the Committee to present to each meeting a short resumé on preservation of timber, so as to keep the subject before the members at all times. It is intended to make use of the statistical information furnished for discussing these methods from time to time.

The third section of the report consists of the statistics which it is deemed proper to lay before the Association each year as they are gathered by the members of the Committee. Consequently, the whole report is simply a statement of progress; a report of information, collected for the benefit of the Association. The recommendations which the Committee have to make to-day are in regard to the *blanks* on which this statistical information should be collected. The Committee look upon it as of prime importance that the form of blank should be an approved form, endorsed by the Association, so that the information collected each year will be uniform and not subjected to change at the changing of the committees, according to the personal views of the members of the Committee in regard to it. I would, therefore, ask the members to vote on each one of the blanks, individually, as it is introduced to their attention, so that we will have something definite to start with. These blanks are not the same as they were last year, and it might go on in that way, so that we may not accomplish anything by reason of our frequently changing the style of blanks. I therefore call your attention to the blank known as "Form No. 1." This shows the general statistical

information in regard to cross-tie renewals, without going into all the details of cross-tie renewals. It is an attempt to present to the Association the general question as a matter of reference and comparison. The grouping is not according to the railroad divisions, but was attempted to be in accordance with the kind of timber used by the several railroads and divisions, as shown by the last column, No. 28, so that in some cases one division may be entirely separated from the rest of the divisions of the same road, owing to the fact that it is using an entirely different kind of wood for cross-ties. Owing to the fact that a number of divisions are using a great many different kinds of woods, preference is given to the one which predominates in percentage. Consequently, you ought to find most of the white-oak-using railroads grouped toward the top, and, of course, they form the larger part of the table. I therefore, without saying anything more, present this tabular form for the approval of the Association and for such criticism as may be deemed necessary to change it and establish its form so that we will have something established to work to hereafter.

President Kittredge:—You have heard the remarks of the vice-chairman of the Committee on Ties, and your attention is directed to the recommendation of the Committee as to Form No. 1. What action will you take in regard to their recommendation that Form No. 1 be approved by the Association?

Mr. Hunter McDonald (Nashville, Chattanooga & St. Louis):—I will ask the vice-chairman of the Committee if he thinks it necessary to issue any instructions with regard to bridge ties? Some roads have a large mileage of bridge ties that are more expensive and of a different character from the ordinary track tie; and in filling out the table, I was in doubt whether I should deduct the bridge ties or not.

President Kittredge:—I suggest that some motion be made to bring this question before the house.

Mr. McDonald:—I move that we return this blank to the Committee, so that they may make it clear how we shall consider bridge ties.

(Motion seconded.)

President Kittredge:—It is moved and seconded that the blank be returned to the Committee with instructions to so amend

it, in regard to bridge ties, as to distinctly indicate the requirements of the Committee in regard to them; how they shall be treated in the report.

Mr. Cushing:—I would like to say a word. All that would be necessary in case of criticism, such as Mr. McDonald's, would be to move that a note be placed on the bottom of the table, with the instructions in regard to bridge ties. The intention of the report is to clear up anything that may be in doubt in regard to it by the footnote at the bottom. It was the intention of the Committee to include the bridge ties with the track ties, because if everybody is using the accounting of the Interstate Commerce Commission, that is a part of the accounting, and consequently the bridge-tie matter is a track-tie charge and would come in with this report. That could be perfectly explained simply by a footnote on the bottom, whether to leave them in or not.

Mr. C. S. Churchill (Norfolk & Western):—Another footnote is perhaps brought out by a discovery on my part—I misinterpreted one column. I went according to my own way, perhaps. There are several roads, I am sure, that have made the same error I have. That is, I gave the tons actually carried over the railroad at any given point; in other words, to get the ton mileage you must multiply by the length of the division. There are other roads that reported the same way. I see that by comparison. I think the fair average life of the tie and life of the rail, too, is the tons that pass over that rail, not the ton miles. You want the tons that pass over it, and over that rail, not the ton mileage. I would like to amend that heading. I think the tons is the correct one.

Mr. Cushing:—I would like to explain first that the same tonnage does not pass over all parts of a division. You have that to consider as well. You will have to indicate clearly the part of the division on which tonnage will be taken.

Mr. Churchill:—This is a question of averaging; whichever way you do, you must use an average.

Mr. Cushing:—Well, we will be glad to change the heading, according to whatever the Association would like in that matter. It was quite a question of discussion among the members of the Committee.

President Kittredge:—The question is on Mr. McDonald's motion. Is there any further discussion on Mr. McDonald's motion? It seems to me that if we return this report to the Committee for some change we will be defrauded out of the opportunity to discuss it in full. It seems to me the proper way to do in connection with this report is to accept the report, and then amend it.

Mr. McDonald:—I withdraw the motion.

President Kittredge:—Moved and seconded that the report as a whole be accepted. Now, the matter is open for discussion. You can move to amend it now.

Mr. McDonald:—I move that the blank be amended, and when it is issued next year specific instructions be given in a footnote as to how the question of bridge ties shall be treated.

President Kittredge:—Mr. McDonald moves, and it is seconded, that Form 1 be so amended that when it shall appear next year it shall be provided with a footnote indicating just how bridge ties are to be treated. Is there any further discussion?

(Motion carried.)

Mr. Churchill:—I would amend the form further, that the "average gross tonnage" passing over each division be the heading for column No. 4 instead of "tons mileage."

President Kittredge:—It seems to me there is a very great difference between tonnage and tons mileage, and that this Association should say definitely and positively which it wants on this report. I can conceive that the life of a tie and the life of a rail are very seriously affected by tonnage, but I can hardly appreciate what the effect of ton mileage has to do with it.

Mr. Cushing:—The ton mileage is the measure of the traffic that the railroad carries.

Mr. Churchill:—I might say the argument is this: As soon as you get the "ton mileage," you must look at column 2, to know what is the length of that particular division of the road. You must divide the former by the latter in order to get the tonnage. If you have, on the other hand, the tonnage passing over that division, you can always get the ton mileage; but you actually want the tonnage itself in order to determine the life and wear of your rail, as well as the life and wear of your ties. The tonnage car-

ried is the basis, as the President says, for gauging the life of both rail and ties.

Mr. W. M. Camp (Railway and Engineering Review):—As I understand Mr. Churchill, he would like the average tonnage for all points of the division. Mr. Cushing has explained that the tonnage over all points of the division may not be the same. Now, the party reporting this information might just as well prepare it for the convenience of the reader, who would otherwise have to divide the ton mileage by the number of miles. It seems to me, then, that it would be better to report the average tonnage for all points of the division.

(The amendment was carried.)

Mr. J. G. Bloom (Baltimore & Ohio Southwestern):—Mr. President, I rise to a point of privilege. There is an error there. The figures in column 24 should be \$212.34. I would like the privilege of correcting that now.

President Kittredge:—Mr. Bloom states that in line 1, column 24, the cost of renewals per mile should be \$212.34 instead of \$94,279. The figure as given was the total cost of the division and not cost per mile.

Mr. Churchill:—Perhaps the Chicago & Northwestern made the same mistake, or something like it.

Mr. A. Torrey (Michigan Central):—Mr. President, columns 25, 26 and 27 are not understood by quite a number of the gentlemen. Perhaps, for the purpose of the Association, that might be separated from speculation on one part of the outfit to knowledge on the other, and doubtless a good many of the gentlemen who have responded know something about it from record, but I do not. I do not want to put in my speculation, and I would suggest that the Committee next year discriminate between people who have kept records and those who have made estimates.

Mr. Cushing:—I would like to call Mr. Torrey's attention to Form No. 1, the footnote on which says—that is, the blank on which the record is to be kept for information—"data for columns 25, 26 and 27 kept on Form 1-B." In other words, all these blanks which follow are supplementary to Form 1. Form 1 is the general information.

President Kittredge:—Is there any further discussion, gen-

lemen, on Form 1? It is moved that Form 1, as amended, be accepted. (The amendment was carried.) Mr. Cushing, do you care to present the next form?

Mr. Cushing:—Form 1-A is the next one, headed Table II. Form 1-A is a more detailed comparison between the different kinds of woods and preserving processes and will explain in many cases why the service of ties on some railroads is longer than on others. The blank has been prepared in such a way that it will be unnecessary to split it up for tabulation and printing, as was done last year. It is, therefore, more convenient for examination. It is practically the same blank that was presented to the Association last year, but is in a consolidated form, so that the different roads will appear on the same blank and in comparison. Last year it was cut up in such a way that it really did not mean anything. I will call the attention of the Association to the fact that while this is a table which furnishes the information for column 28 of Form 1, nothing like the same number of roads filled it out as they did Form 1, although it is much the same information in actually working it up in the office. I do not know why it was avoided.

President Kittredge:—Gentlemen, what is your pleasure in regard to Form 1-A?

Mr. McDonald:—I move its adoption.

President Kittredge:—Moved and seconded that Form 1-A be adopted. If there is no discussion, those in favor will signify by saying aye. (The motion was carried.) Does Mr. Cushing desire to present Form 1-B?

Mr. Cushing:—Form 1-B is the life record of ties in detail for a great many years. This is a form which very few roads are able to fill out at the present time. It is given, however, in order to get everyone started in keeping it, so that they will be furnished with full information as to the life of their ties. This is the table which should give the information for filling out those columns 25, 26 and 27 of Form 1. It is practically the blank used by the Southern Pacific Company, except that it is somewhat changed in arrangement, as it was believed it would be a little more clear to the Association. When the blank was presented last year to the Association, nobody knew how to fill it out; in fact, it was not filled out, except by the Southern Pacific Company,

correctly. Some attempted to fill it out, but the information was not what it was intended to be, and the chairman in his report last year called attention to that fact. This is a blank or form which must be printed separately for each division that fills it out, as it is impossible to make it in such a way that it can be tabulated for several divisions. Consequently, we only have two presentations of it in this report—one by the Southern Pacific Company, Atlantic System, and the other by the Southern Pacific Company, Pacific System, the Pacific System being shown, much reduced in size, as Table IV. The information, however, or the form of information, is precisely the same in each case, but the Atlantic System had more details to give. That is a very complete record since 1887, although they have it for even longer than that, but that was considered far enough to go back, and it gives a very complete record up to date. This can be used not only for keeping a record of treated ties separately, but for keeping a record of any ties where the roads have begun to mark them with some distinctive marks, so they will give the year in which they were laid. It cannot be used by anybody unless the year in which the tie was laid is known.

President Kittredge:—Gentlemen, what will you do with Form 1-B?

Mr. A. W. Johnston (New York, Chicago & St. Louis):—I move that it be approved.

(Motion seconded.)

President Kittredge:—The form is open for discussion. Has anyone any discussion or questions to ask about it? Those in favor of adopting Form 1-B will signify by saying aye.

(Motion carried.)

Mr. Cushing:—In this same connection I will call the attention of the Association to page 9 of the report, where a method for marking ties is given, as adopted by Dr. Von Schrenck, in making some tests which he has already started, and it is not a bad idea to consider those methods of marking when anyone is taking up the subject of cross-tie marking. I will now call attention to Form 1-C. This is statistics of treated ties exclusively. It is practically taken from the Cross-Tie Committee's report to the International Railway Association, held last year, and it gives the details of the methods of treatment, so that it is

entirely supplementary to the information in the other table. Form 1-B is the life record of the ties, which can be kept in as much detail as is necessary, and 1-C gives the inside history of the treatment.

Mr. W. S. Dawley (Chicago & Eastern Illinois):—I move the adoption of the blank.

(Motion carried.)

Mr. Cushing:—On page 14 of the report is Form 1-D. There is no statistical information given on this blank, as it is intended as a suggestion for a blank to be used by the divisions who are collecting information in regard to life of ties, to be placed in the hands of the section foreman for making his report. I may say again that this is practically the blank used by the Southern Pacific System for the same purpose. It can be used as a blank for treated ties or for any other ties that are marked, as the members may see fit. It is simply offered as a suggestion, which each company would print for itself, and would be simply used on the division. I presume it will be proper to have the Association pass on the blank and see whether it approves of it or not.

President Kittredge:—What will you do with Form 1-D, as shown on page 14 of the report?

Mr. McDonald:—I move its adoption.

(Motion seconded.)

President Kittredge:—It is moved and seconded that Form 1-D be approved. Those in favor of its approval will signify by saying aye.

(Motion carried.)

Mr. Cushing:—Tables VI, VII and VIII, on the last two pages of the report, are voluntary contributions on the part of the Southern Pacific Company, Atlantic System, and the information was considered of such value by the Committee that it decided to print them as given, in order to make them a matter of record in the proceedings of the Association. It is such information as we hope each of us will be able to give in the course of time, but very few of us could give it now, and they have not been stamped with any form or blank number. They are simply given for the value that they have. It may be that the Committee may have something to recommend in regard to blanks of that kind later on, but the Committee has nothing at present. In closing the report

I would call attention to the article on preserving methods, which I think has been very well analyzed up to date. That is a live subject for all of us, and I do not think can be emphasized too much. We are fast being deprived of timbers close to us, and we are being forced to use timbers which we have heretofore considered as unfit for cross-tie purposes. It really looks as though the preserved tie was the intermediate step between what we are now using and the metal tie or timber cultivation.

President Kittredge:—We have acted upon the recommendation of the Committee on Ties. It is now proper that we should accept the Committee's report as a whole. The Association is to be congratulated upon having a report submitted in the manner in which this report has been submitted, and the other committees can well look upon this as an example of what the Association needs. It would be perfectly proper for somebody to move that the report as a whole be accepted.

Prof. C. F. Allen (Massachusetts Institute of Technology):  
—I move the adoption of the report and its acceptance.

(Motion seconded.)

Mr. McDonald:—There is one thing that occurs to me that we ought to do in connection with this report, and that is, try and secure the coöperation of railroads in furnishing the Committee the data necessary to fill out these blanks, and some steps by our Association ought to be taken to secure the system of marking on all the different roads that is recommended by the Committee. I move, if it is in order, that our Board of Direction be instructed to communicate with the management of the different roads, and urge upon them the importance of adopting the system of marking that has been outlined in this report.

President Kittredge:—The suggestion of Mr. McDonald is an excellent one, and after the motion to accept the report as a whole has been acted upon, we will take that up. Is there any further discussion on this report of the Committee? If not, those in favor of accepting the report as a whole will signify by saying aye.

(Motion to adopt the report as a whole carried.)

President Kittredge:—Now, Mr. McDonald, do you wish to make a motion to the effect that the Board of Direction be instructed to take up with all railroads in the country the question

of statistics in regard to ties, urging them to adopt the marking recommended by this report, upon which the Association has put its stamp of approval?

Mr. McDonald:—I do.

(Motion was seconded.)

Mr. F. H. McGuigan (Grand Trunk):—I second that motion, and in doing so I want to point out an error that has been made in reporting the life of the ties on the Grand Trunk, which is shown here as an average of six years. We know that on many of our branch lines probably 75 to 80 per cent of the cedar ties have been in the track 12 to 15 years. We do not know the exact life of the cedar ties now, but if the report is based on the ties used during the past five or six years, it is a mistake, as our track was formerly laid with an average of 2,640 ties to the mile, which we did not consider sufficient to carry our increased tonnage, therefore increased the number to from 3,000 to 3,200 per mile in main lines.

Mr. Cushing:—This information is supposed to have been tabulated from blanks filled out by somebody. The Committee did not go to the trouble of doing it itself. I would like to ask Mr. McGuigan if he would like to have that cut out, or the whole information cut out?

Mr. McGuigan:—Yes, it is inaccurate, and should be eliminated.

Mr. Cushing:—In printing it in the proceedings, whatever corrections members desire to be made can be made.

Mr. McGuigan:—Yes, it would give a false impression and convey improper information in regard to the life of the tie. I think it is very important that it should be eliminated from the report of the proceedings.

Mr. Cushing:—Certainly; if it is not correct, it ought to be.

President Kittredge:—Is there any further discussion upon the motion before the house instructing the Board of Direction to take up with the railroads the question of the statistics and marking of ties? Those in favor of the motion will signify by saying aye.

(Motion carried.)

Mr. Roland Woodward (Jacksonville & Southwestern—by letter):—There are cypress ties in Florida that have been in

the track ever since our road was constructed, some 25 years ago. These ties have been cut in two by the wear of the rail before they were abandoned. Until about three years ago, cypress was not considered good for ties, on account of being so soft that the spikes were not supposed to get the proper grip; since then their value has been more appreciated. In this climate a good cypress tie will wear out before it rots, and I believe with a proper tie plate they will last indefinitely. Oak ties will not last three years in this climate. In 1896, the road I was connected with commenced the treatment of sawed ties and bridge timbers with "Carbolineum Avenarius," applied hot by immersion, the timber being yellow pine. Three years afterward the surface of the ties appeared to be perfectly sound as they lay in the track, but on investigation the interior of the ties in a majority of cases was found to be dryrot—the more heart the ties had the better condition they were in. The claim for this preservative was that it attacked the sap better than the heart, and for this reason the sap ties were the best, but experience taught otherwise.

Mr. O. Chanute (by letter) :—As foreshadowed in the report of the Committee on Ties, American Railway Engineering and Maintenance-of-Way Association, for 1902, the Chicago Tie Preserving Company experimented with the zinc-creosote process at its Mt. Vernon (Ill.) plant in May, 1902, treating some 15,000 red, black and water-oak ties.

The work was purely experimental, the increased cost being borne by the company in order to ascertain whether the tar-oil, which had been imported, was suitable for emulsion with chloride of zinc, whether the details of the process were thoroughly understood, and whether the indigenous inferior oaks of Illinois would take the treatment well. The latter was found to be the case, the results being satisfactory from the very start. Specimen ties, upon being sawed in two, were found impregnated to the center, and to resemble in appearance the examples of ties treated with chloride of zinc and tar-oil illustrated (Plate XIV, Figs. 1 and 2) in Prof. Von Schrenk's recent report to the United States Department of Agriculture on "The Decay of Timber," issued March 25, 1902.

It is well known that in burnettizing, the chloride of zinc seldom penetrates at once to the center of the tie, although it dif-

fuses itself thereto after some days or weeks; but with the zinc-creosote process, it seems to penetrate more rapidly, some of the mixture being found at the very center of the ties upon their being sawn across immediately after treatment.

Sections from the middle of these ties have been sent to the Shaw School of Botany at St. Louis, to be placed in its fungus pits and inoculated with the elements of decay. Approximate results may thus be expected in a shorter time than in the track, but the final results as to the life of these ties, which are to be laid on the Chicago & Eastern Illinois Railroad, will not be known for several years. They are expected to average fourteen to sixteen years in the track, as similar treatment is said to impart an average life of fifteen to eighteen years in Germany when the work is well done.

The increased cost over the zinc-tannin process is estimated at six cents per tie, when various wastes attending a first experiment are eliminated. The main point ascertained is that the zinc-creosote process can now be worked commercially in the United States, but that it will probably involve importing the tar-oil from Europe until arrangements can be made to produce the peculiar quality requisite in this country.

President Kittredge:—Gentlemen, we listened last year to some remarks by Dr. von Schrenk, who is connected with the Department of Forestry, and he is here to-day and I have asked him to tell us a little about the work done in the past year on the subject of timber decay in the Department of Forestry. If Dr. von Schrenk will step to the platform and address the Association for fifteen minutes, we will be pleased to listen.

Prof. Hermann von Schrenk, United States Department of Agriculture and Shaw School of Botany, St. Louis, Mo., addressed the Association as follows:

Last year I addressed your Association and outlined in a brief way what we thought might be the function of the National Government with respect to the timber supply of this country. That this subject is of vital interest to all railway men is evidenced by the careful and elaborate report just made by your Tie Committee, and the valued suggestions contained therein. On behalf of the Department of Agriculture, I want to tell you what we have attempted during the last year, and to outline to you what we hope to accomplish in the near future.

The work has naturally divided itself into three parts. At the suggestion of the Tie Committee, we attempted, last year, to formulate a gen-

eral scheme, in order to obtain a timber census of the United States. In order to secure this information, it was necessary to address all of the important consumers of timber in this country, and although the statistics are still very incomplete, we have, at the present time, some figures which can be relied upon. This work will be continued, and by the end of the year we hope to have statistics which will be of considerable value to the consumers. You would be very glad if we were able to tell you, at the present time, how much available timber there was along your various lines. However, you must realize that in order to obtain this information an immense amount of correspondence is required, and the statistics must subsequently be compiled with the greatest care and accuracy, in order that they may be of any value whatsoever. To obtain anything like a complete census, it will be necessary to have more ample means than are now available, and a great many more trained men to carry on and accomplish the work.

The possibility of making use of inferior grades of timber is a fascinating problem to study, and one on which we are now engaged. In order to make practical tests of various kinds of timber, which have been subjected to the different treatments, we have placed on the Santa Fe road, in Southern Texas, an experimental track, in which we have laid about 8,000 ties; representing fifteen different kinds of woods, which have been subjected to seven treatments. This track was completed about three weeks ago. Each tie is marked by three special record nails, indicating the kind of wood, the treatment to which the tie was subjected, and the date on which the tie was placed in the track. This particular section of track was selected because it was found that decay is most rapid on this branch, and we wished to obtain comparative results at the earliest possible moment. It is hoped that within the next two years we will have valuable information from this track, indicating the relative value of various treatments on the several woods used. Of course, this information will only be of practical value to the particular section of country in which the track is laid. A report of this experimental track will be contained in a bulletin, entitled, "The Decay of Timber," which bulletin I shall take pleasure in having mailed to all the members of this Association, within the next ten days. If we can prove to you, from observations made on this track, that inferior grades of timber, when subjected to certain treatments, will increase, economically, the length of life of the ties, of course you will be able to reduce the consumption of the more expensive kinds of timber, adjacent to your tracks, by making use of these inferior grades. At the present time, the substitution of the more inferior grades has not been satisfactorily accomplished.

We purpose to extend these experiments, on a very much larger scale, with the ties, in actual service, in the roadbeds. In order to do this, it will be necessary to ask the coöperation of every railway in the country. If they will contribute to these experiments by making treatments of various ties, representing different kinds of woods, and subject these to the different processes suggested, and then turn these tracks over to us in or-

der that we may have competent men make observations on the particular section of track, from time to time, we will be enabled to obtain reliable comparative records regarding these various timbers, when subjected to certain treatments, for different sections of the country. It is important to know what effect the varying climatic and geological conditions have upon the ties in the roadbed, and we propose to obtain this information in the manner described.

One other point I wish to emphasize is this; we have now come to the time when the good old slovenly way of dealing with timber, not only among the railroad people, but also among those who use structural timber, must pass away; and we must adopt such means and methods as will secure longer and better service. The secret of the successful service obtained by European roads, as I saw it last summer, and as I was told by most of the engineers in charge, could be summed up thus: They realize that a treated tie, if it is worth treating, is worth taking care of after it is treated. That implies, of course, that the treatment is only half of the undertaking. Treating a tie involves chemical processes which must be thoroughly understood, and it is not as easy as might be supposed. In Europe, the treating work is in charge of trained and efficient chemists; accurate inspection is made of every carload of material, both before and after treatment. In other words, they regard the tie as something worth handling and taking care of throughout the whole process, from beginning to end, and that is one of the reasons why they get such great length of life from their ties.

A much neglected phase of this question has to deal with the proper seasoning, before use, of the ties. We are about to start on some experiments, involving 3,000 ties, which have been loaned to us by certain railways in various parts of the country. These ties will be weighed every week, so as to determine the most practical way of seasoning them before they are placed in service in order that greater life can be obtained by this means. It has been determined that by piling ties in a certain manner, they season quite rapidly; and the life insured in consequence of this seasoning is almost doubled. We hope to be able to give practical demonstration of this in the twenty miles of experimental track soon to be laid in different parts of the country.

Last year I spent three months in Europe, and visited various experimental tracks now in service in England, Germany, France, Russia and Italy; obtaining what information I could from personal observations I was enabled to make thereon, and from statistics to which I had access. I must express my appreciation to many railway men of this country for numerous courtesies which were extended to me at your instance by foreign railway officials. Because of credentials carried by me, I was enabled to obtain special cars and had permission to remove ties from the track, to obtain many valuable records, many of which I regret cannot be published, inasmuch as they are in the nature of private communications. This private information, however, is now in the records of our Department and can be consulted in a confidential manner. A great deal of information, and many of the statistics which I obtained, will appear in my report, of which

I have just spoken. I hope that you will all find time to examine this report, and in case you have criticisms or suggestions to make in regard to what we purpose to do, or what we are now doing, I shall be under many obligations if you will write me direct. It is only by such suggestions, criticisms and coöperation that we will be enabled to obtain results which will be of absolute value to all concerned.

I want to emphasize the suggestion made by Mr. McDonald in regard to the keeping of records on various roads. You who have examined the tie records which have been kept by the different roads in the country have probably noticed the impossibility of drawing any reliable conclusions as to the value of certain kinds of timber. During the last year I have had occasion to examine many tie records kept by various roads and I find the figures greatly misleading and unreliable. Any conclusions, drawn from great columns of isolated figures, showing you how many ties were removed from the track, are of little value when determining the value of the life of a great many kinds of different timbers; especially so inasmuch as these various timbers, laid in the same track, side by side, have no adequate distinguishing mark. In case the ties are marked for record purposes, it is absolutely necessary that they be marked in such a manner that when the ties are removed from the track, there will be no question as to the interpretation of the mark contained thereon. Certain kinds of steel record nails, which have been heavily coated with zinc, and stamped with a die on the head, are to be recommended for this purpose. It is an extremely bad practice to brand the ends of the tie with a stamp, because out of 500 ties removed, 25 ties of this number will have an illegible mark on the end. This, you will readily see, vitiates the whole record; and, notwithstanding the published accounts which engineers have given you, which records have been based on statistics gathered from ties branded on the ends, I am strongly inclined to dispute the reliability of any such records so obtained. We shall endeavor to persuade railway men of this country to start to marking ties with record nails, so that we can have access, to examine, various tracks in different sections of the country, and extend such examinations over a period of at least ten years, under the supervision of the Government. I am sure you will all be impressed after studying the tables which your Committee has brought before you with the great gaps in these tables, and you will readily see the necessity for insisting that the proper records be started at once and kept with the greatest accuracy.

It is further proposed to do experimental work with tie-plates, ballasting and incidental matters connected with the use of a particular tie when subjected to a particular treatment.

In conclusion, I wish to thank you for the coöperation already established, and to ask your suggestions and assistance as we may need them from time to time. [Applause.]

President Kittredge:—Gentlemen, we have fifteen minutes more, and we have one short report on the subject of Signaling and Interlocking.

REPORT OF COMMITTEE No. X.—ON SIGNALING  
AND INTERLOCKING.

*To the Members of the American Railway Engineering and Maintenance-of-Way Association:*

The work outlined and so well started by your Committee during the years 1900 and 1901 has been seriously retarded this year on account of the changes in membership and chairmanship. None of the original members are left; some of the changes coming so late that the "new hands" have had scarcely time to catch up with what has already been done.

The rapid development in the science of signaling and interlocking makes the subject one of absorbing interest. Its relative importance in the economical and safe handling of trains and in the increased capacity afforded to traffic cannot fairly be gauged by a comparison of the Auditor's yearly account of expenses for maintenance and operation.

How to effect a saving is a problem always to be solved, but it frequently happens that the solution does not depend upon individual effort. This is the case as it stands to-day with regard to the adoption of standard designs at Joint Interlocking Plants.

There must be an organized effort on the part of all the roads concerned if anything of importance is to be accomplished. With this idea, your Committee has made an effort to get an expression of opinion from forty-three railroads by sending to each a set of six prints selected from the drawings prepared relating to the appliances involved at these plants. The railroads were asked to send prints of their own standards covering the same and to make suggestions and recommendations on those sent them.

These plans were sent out during February, too short a time before this meeting to get enough answers for us to report upon, but the few we have received lead us to believe that the idea will receive general endorsement and that the answers will enable us to come before you next year with plans and specifications in proper shape to recommend to the Association for adoption.

Much of the apparatus shown on the plans that were submitted last year for the Association's criticism, and which are herewith again submitted for the same purpose, are already recognized as standard by many roads, but we are of the opinion that more of the roads asked to express their opinions should be heard from before asking the Association to take action on any. Some of the subjects contained in the expanded outline which appears in the Proceedings of the first annual convention are of such a nature that fixed standards cannot be recommended, because local conditions will govern. A consideration of these governing conditions is a part of the future work of the Committee.

The small membership and the limited amount of time that each member can devote to committee work precludes the possibility of taking up more than one or two leading subjects at a time, and in the absence of

definite instructions from the Association as to what particular subject they wish the Committee to work on, it will select that which it believes to be of most general interest affecting all roads.

This is the method proclaimed last year, and is obviously correct, although it means a long time before some of the most attractive subjects will be reached. Power-plant systems, automatic block systems, electric locking, and the question of a time release as a substitute, are live subjects, and a study of which equipment is best suited for certain arrangement of tracks and switches and traffic conditions will be made and reported upon.

On the subject of standard designs and specifications for interlocking plants, the Association's opinion was asked at the last meeting about the desirability and practicability of adopting a single type of fixed signal for all interlocking and block purposes.

We present the question again for your consideration. In respect to its desirability we have this to say: Over one hundred designs of semaphore castings are now on the market and in use, many of which are bad and do not embody correct principles. The good ones differ in unimportant details. We demonstrate the practicability on attached sketch, which is respectfully submitted. It has been customary to consider a different design necessary for different degrees of travel of the signal arm and light casting. Figures 1, 2 and 3 illustrate a form of casting adapted to the three-position signal, the two-position signal with 90 degrees, 70 degrees or 60 degrees travel, the only difference being that a separate spectacle is required for each.

The castings are shown mounted on side bearings, but they are equally well adapted to the center bearing. The only change required is the lamp bracket.

Fig. 1 is the only one that does not show the continuous light principle. It can easily be included by use of glasses, shaped as shown at Fig. 3.

Fig. 5 is shown in detail among the plans submitted.

Fig. 4 shows the same type with round glasses.

If any road prefers to carry less glass in the semaphore casting, the center light may be made blank. All are designed to take a green glass, should that color be adopted for the clear indication.

Respectfully submitted,

J. C. MOCK, Michigan Central R. R., Detroit, Mich., *Chairman*;

J. W. THOMAS, JR., N. C. & St. L. Ry., Nashville, Tenn., *Vice-Chairman*;

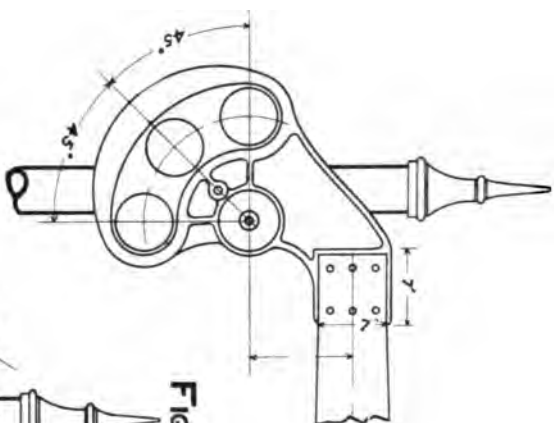
T. S. STEVENS, Santa Fe System, Topeka, Kan.;

A. H. RUDD, Delaware, Lackawanna & Western R. R., Hoboken, N. J.;

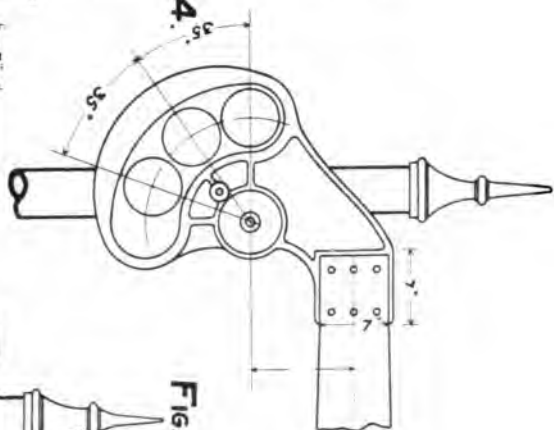
*Committee.*

Mr. J. C. Mock (Michigan Central):—I thought, inasmuch as the Committee had held but one meeting, and that was during February, and the chairmanship coming to me at such a late date, that it would be hardly possible to make a report that would

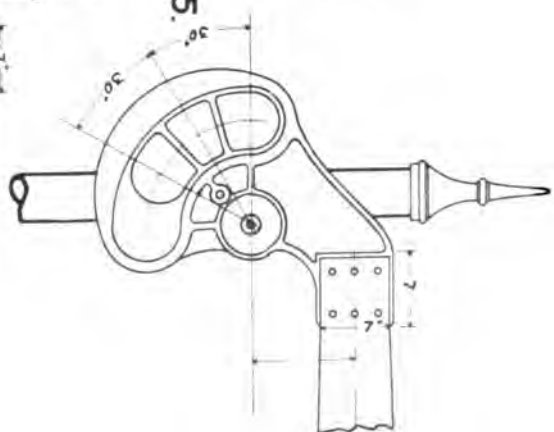
**Fig. 1.**



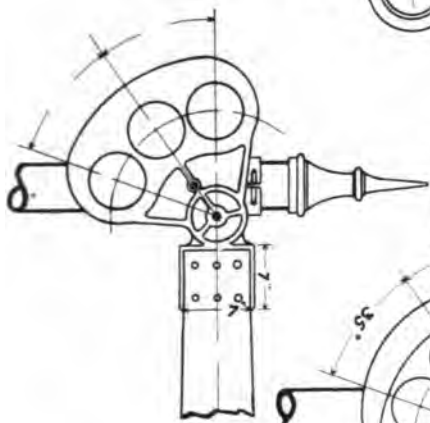
**Fig. 2.**



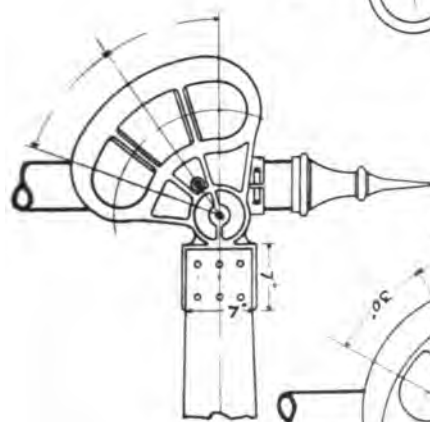
**Fig. 3.**



**Fig. 4.**



**Fig. 5.**



be satisfactory or to make recommendations which we would want the Association to take final action on. We have prepared a great many plans of standard materials and appliances, and we would like very much to be instructed—to have these plans criticised. We would like also to have an expression from the Association as to whether they would recommend or adopt the continuous-light principle. This matter has been before the Association for two years, and we find that the manufacturers are not giving the attention to the continuous-light principle that we believe the matter deserves. We will have our plans revised and sent out during the year for the roads to consider the subject. The plan that we wish to act upon will be to make such revisions in these plans as the criticisms that we have asked for will suggest; then to send them out early enough so that the roads can have the benefit of early consideration, and next year we will probably be able to do something toward adopting designs; the specifications will also accompany this revision and recommendation of plans.

President Kittredge:—As stated by the chairman, this Committee has been most unfortunate. It has had during the year some three or four different chairmen, and the last resignation came so late that it was really impossible for the present Committee to make much more than a start. The report of the Committee is before you, gentlemen, for action.

Mr. Edwin F. Wendt (Pittsburg & Lake Erie):—Mr. Chairman, as I understand the chairman of the Committee, he submits to the Association a certain question and asks that the Association express its views with regard to continuous-light principle. It seems to me it would be well to have that submitted to the members of the Association by ballot during the year, as undoubtedly most of the members in attendance upon the convention are not prepared to vote on the question.

President Kittredge:—Do you make that in the form of a motion?

Mr. Wendt:—I move that the question be referred to the Association during the coming year by ballot.

(Seconded by Mr. Dawley.)

President Kittredge:—It is moved and seconded that the Association indicate by ballot its stand upon the question of the continuous light in signals. Any discussion on the question?

Mr. H. D. Miles (Michigan Central):—In considering the question of continuous light, does the Committee desire also to have the Association consider the question of the position of the signal arm? This seems to be a question which should be settled, if possible, as well as the question of the desirability of using a continuous light, as each affects the design of the signal-arm casting. The question of having separate and distinct positions of the signal arm for the stop, caution and clear indications was brought up last year, and the Committee at that time expressed a desire to have the Association arrive at some conclusion in regard to the matter. At that time the question of a continuous light was also mentioned, but was not referred to specifically. It is quite evident that in considering one subject, both should be considered. It is doubtful, however, if definite results can be secured unless drawings of the different designs are sent to the members of the Association and the matter voted on by letter ballot. I know that the Committee previously had considerable trouble in getting any expressions of opinion. The members of the Association are not, perhaps, many of them very familiar with signaling, and that is one of the drawbacks in considering the subject.

As an old member of the Signal Committee, I would urge that the members of the Association give more heed to the requests of the Committee than has been given in the past.

President Kittredge:—I believe it is apparent to all the members who are present to-day that the coöperation of the members themselves is absolutely essential in order to enable the committees to make an intelligent report and the kind of a report that this Association should receive, and we cannot too strongly urge upon the individual members their coöperation. When requests are received, they should be attended to and returned promptly, with the information given in as nearly the form asked for as it is practical to do. There is a motion that the question of continuous light be submitted to the Association by ballot during the year. Does Mr. Miles desire to amend the motion by adding the question of the position of the signal arm?

Mr. Miles:—I do not care to make a motion to amend, but would suggest that the Committee draft a proper question to be submitted as outlined in my previous remarks. Last year, when

this subject came up, some of the members seemed to think that in recommending a three-position signal, capable of giving a distinct position for each indication, viz., danger, caution and clear, that it would be in conflict with the recommendations of the American Railway Association. I find in looking over the standard code that there is no conflict. It is stated in the code that a signal shall not give more than three indications; therefore, in considering the subject it should be understood that such a recommendation from the Signal Committee does not conflict with the recommendations of the American Railway Association.

Mr. W. C. Cushing (Pennsylvania Lines):—I will suggest that when the Committee sends out any questions with regard to the position of arms it is well to present diagrams, so that there will be no misunderstanding as to what is meant. As to the continuous-light principle, I think it would be well to have the chairman of the Committee elaborate a little on what the Committee considers its advantages. We who have not used it do not see any advantage at the present time, but are open to conviction. Personally, I do not see any advantage in the continuous-light principle, and it would seem to me possibly there might be some others feeling the same way.

Mr. Mock:—The continuous-light principle has advantages, because in times of snow and sleet, or derangement of parts, the arm is liable to droop sufficiently to show a white light. The hiding of the light gives no information, and is about as dangerous a condition as having no signal. Suppose the derail is right in your front—you have no light, no means of locating your position on the track, and the chances are you will overrun your signal and go off the track. The continuous light is intended to show a danger condition until the signal is entirely clear. The probabilities are that the signal will not remain in that extreme position if any derangement occurs. It may get in the middle position or go to "danger." The designs are all intended to have it go to "danger," but there are so many things that might prevent that, as a broken wire, which will allow the signal to go partially to "danger." In that case you get a "danger" indication—which you should get—whereas, if you did not have continuous light, you would get either no light or a white light, with many present designs of signal castings. The sketches which are

submitted in the report are merely to show the possibility of adopting one signal form of casting for the various degrees that are now in use—60 degrees of travel upon the arm—some using 90 and others 70. Should you want to change from the 60-degree traveler to a 90-degree traveler, or from the two-position signal to a three-position signal, the same casting would answer the purpose.

Mr. Cushing:—That continuous-light principle is not necessary to cure the difficulty. That trouble has been cured by the addition of a small shield in continuation of the casting. It can be made out of zinc or any other metal; it certainly avoids the use of extra glass, which is subject to being broken. There are only two glasses in the signal, one of which is red and the other green. Either of those is given unless the blade drops beyond a certain amount, say beyond 20 degrees, or something of that kind, in which event the white light will be clear, were it not prevented by the shield. We do not use three glasses.

President Kittredge:—The motion is on instructing the Committee to get by letter ballot the question before the Association on the question of the continuous-light principle and the travel of the arm.

(Motion carried.)

Mr. T. L. Condron:—Before the Association adjourns, I wish to announce that the Committee on Arrangements has completed arrangements for a dinner in this hotel to-morrow night, which probably a large number of the members wish to attend. The hotel people are asking the Committee frequently how many are going to be at the dinner. It is necessary to know as early as possible how many will attend. The Committee has been to some pains to provide for the guests, and we will be pleased to have all who expect to attend secure tickets either at the table outside of this room or at the hotel desk.

The meeting adjourned until 9:30 a. m., Wednesday, March 19.

**WEDNESDAY, MARCH 19, 1902.**

The meeting was called to order at 9:30 a. m., President Kittredge in the chair.

President Kittredge:—The first Committee to be heard from this morning is the Committee on Ballasting. The Secretary will call the names of the Committee, and as the names of the gentlemen are called, they will please step forward and take seats upon the platform.

**REPORT OF COMMITTEE No. II.—ON BALLASTING.***To the Members of the American Railway Engineering and Maintenance-of-Way Association:*

This Committee has also been unfortunate, but we will leave our troubles untold.

Our chairman, in his report to the Association two years ago, defined ballast as "the material above the roadbed in which the cross-ties are imbedded, and its object is to get a solid and uniform bearing for the cross-ties, to distribute the applied load over a large surface of the roadbed, to hold the cross-ties firmly in position, to give elasticity to the track and to allow the water to pass off freely, thus avoiding churning in wet weather, and heaving by frost." We will not attempt to change his definition, but we will add, incidentally, that it should prevent the growth of weeds and prolong the life of the tie.

**MATERIAL.**

A material suitable to perform the functions of ballast must be in small, angular pieces, hard enough to resist the load and tamping without material injury; it must be relatively free from decay and unaffected by weather; it must permit of easy handling and provide good drainage. The materials which practice has found to fulfill the conditions required, more or less perfectly, are broken stone, gravel, coarse sand, burnt clay, partially disintegrated rock, slag, cinders, and various products resulting from the separation of ores, such as chatts, Joplin gravel, etc.

STONE.—The varieties of stone usually considered suitable, and commonly obtainable at reasonable cost, are trap rock, granite, magnesium

limestone, hard limestone, hard, dry sandstone, having over 95 per cent silica. These materials, when too coarse, crushed into approximately cubical pieces of from three-quarters of an inch to  $1\frac{1}{2}$  inches in diameter, probably give the best results. In practice we find a maximum of from one and a half to three inches allowed.

**GRAVEL.**—Gravel to make good ballast must be composed of firm particles that will not rapidly decay, and from sizes running from coarse sand to one and a half inches in diameter. It must be sufficiently free from clay and soil to drain freely. Gravel containing boulders, round pebbles and considerable clay can be made into first-class gravel ballast by passing through washer and crusher, the larger boulders being crushed into small irregular masses, giving a superior holding quality on the tie. The washing will make the ballast drain, so that it will not churn in wet weather.

**COARSE SAND.**—Coarse sand, where the particles are angular, may be used for ballast, but usually washes easily, but is apt to blow in dry weather and is exceedingly dusty under fast trains, unless it is that peculiar quality of sand which seems to cement together and will stand at a very high angle of repose.

**BURNT CLAY.**—Burnt clay has been used with varying results, depending on the quality of the material burned and the manner of burning. Clay containing little sand and a sufficient quantity of fluxing material to produce a semivitreous mass has undoubtedly made a fairly good ballast. It drains well and makes good track. On the other hand, much burnt clay ballast has been put into track which has been too soft to stand the load and has disintegrated under the action of the weather.

**PARTIALLY DISINTEGRATED ROCK.**—In many parts of the country there are deposits of rock that have become partially disintegrated through ages which contain much hard material that will form the main body for ballast, while the other material is sand-like or of a nature that will not clog the drainage, and such partially disintegrated rock, in some instances, will form an excellent ballast which promises to be very durable.

**SLAG.**—Blast furnace slag, containing a small excess of lime and being of a glassy nature, when broken up under the track, fulfills the requirements of ballast to a very large degree. If a large excess of free lime is present, it soon becomes too soft to hold the load, becomes concreted under the ties and churns in wet weather. Slag-ballasted track usually requires a lift of two or three inches and to be surfaced out at face at intervals of from two to six years, depending on the hardness of the slag and the amount of traffic. Slag composed almost exclusively of hard, glassy pieces approaches closely to the quality of rock ballast; on the other hand, slag with a large amount of free lime is inferior to reasonably good gravel.

**CINDERS.**—Engine cinders find a place as ballast, particularly on soft sub-grades and branch lines, and while they drain well, they usually do not hold up well under extremely heavy traffic, and in some cases these cinders contain materials which, acting on the tie, shorten its life.

CHATTS, JOPLIN GRAVEL, ETC.—These materials make a ballast which holds its surface well, but not always its line. They are usually dusty under speeds exceeding forty-five miles an hour. They are extremely easy to work, are not affected by wet weather, keep down weeds and make excellent ballast in yards and on roads where there is not a heavy passenger service at speeds of fifty miles per hour and upward.

### BALLASTING.

Before ballasting, a subgrade or roadbed is required. It is of very considerable importance that this should be of suitable cross-section and material before ballast is applied. In ballasting, we have two kinds of conditions: One where new track is to be laid and ballasted, and, second, old track which may have had more or less material which has been used as ballast in the past. The requirements of the subgrade or roadbed are that they should of themselves drain freely and that they should be of sufficient sustaining power to carry the traffic without appreciable settlement when the load shall have been distributed with some degree of uniformity over a strip about two feet wider than the length of the ties. In practice, it is sometimes necessary to apply something which might be called a sort of a "sub-ballast." If the material of the roadbed is such that it will not support stone ballast, or any other coarse ballast, without its becoming imbedded in it and causing the mud to work up through the ballast and allowing the ballast to be continually settling, some intermediate material must first be placed on the roadbed, care being taken that any impervious material is of such contour that the water can drain freely from its top. Usually cinders, gravel or screenings will answer for this purpose; sometimes coarse rock, from ten to thirty pounds in weight, will perform this function better.

### DEPTH OF BALLAST.

The necessary depth of ballast below tie is determined by several conditions. The conditions usually ruling are that the load shall be distributed by means of the ballast so that the load on the ties distributed to any part of the subgrade shall not be above its sustaining power. On extremely hard subgrade, the depth required is that which will allow of such distribution of the load on the ballast and such uniformity of material under the tie that there will be no crushing of the ballast itself, or no danger of springing or breaking the tie. Material which will stand at approximately a one-to-one slope, like crushed stone, will distribute the load with reasonable uniformity at a depth not less than the distance between the bearing surfaces of the ties; with other material, which will stand at a lesser angle, a greater depth would be required. It is doubtful if, in practice, a lesser distance than eight inches under the ties can reasonably fulfill the above conditions, and we believe that it is highly probable that twelve inches of depth usually fulfills these conditions within a reasonable degree, and would recommend that eight inches of depth under the ties be the minimum depth for any class of ballast.

## BALLAST CROSS-SECTION.

The following recommendations as to ballast cross-sections are presented:

**ROCK BALLAST.**—Depth below tie, eight to twelve inches; top surface of ballast, top of tie; slope of ballast, from top of tie at a point eight inches outside of end of tie, at the rate of one and a quarter or one and a half to one.

**GRAVEL.**—For gravel containing an appreciable amount of clay and not too easily drained under all conditions—depth under tie, from eight to twelve inches; top of ballast between rails, top of tie; top of ballast at end of tie, bottom of tie; slope to subgrade, two to one.

In our opinion, there is no one cross-section which can be used for all classes of gravel ballast to advantage. In gravel ballast, which drains very poorly, it will be necessary to leave the end of the tie open to avoid churning. As the gravel becomes more and more pervious, lighter and has less coherent parts, the top of the ballast may be brought up on the end of the tie, until, in light sand ballast having usually worn particles and draining very freely, it will be necessary to bring it above the top of the tie at the end, and even carry the top of the ballast some distance beyond the end of the tie before starting the slope. In some ballasts of this nature, better results are obtained by raising the top of the ballast between the rails above the top of the tie.

For crushed and washed gravel, the cross-section for stone may frequently be used.

**CHATS, DISINTEGRATED STONE AND COARSE SAND.**—Chatts, disintegrated stone and coarse sand, which thoroughly drain—depth of ballast below tie, eight to twelve inches; top of ballast from one to two inches above top of tie; top of slope, six inches beyond end of tie and even with the top thereof; slope, one and three-quarters to one to subgrade. We believe that practice has demonstrated that in this class of ballast, particularly the lighter varieties, the tie must be buried in the ballast, or it will blow out, and only under these conditions, where it becomes self-tamping, can the line and surface be satisfactorily maintained. Track put up on this light ballast is frequently knocked out of line, unless the tie is buried and the slope begins some distance outside of the end of the tie.

There are, however, some deposits of partially disintegrated limestone, flint and granite which, in their more solid deposits, can best be given a cross-section closely approximating that of crushed stone. In all these cross-sections, the variations are in that portion of the cross-section representing the top of the ballast from the outside of the rail to the subgrade at the outer end of the slope. The conditions which determine the proper figure of this portion of the cross-section are more than anything else dependent on the draining qualities of the material used; second, as to whether the pieces are angular, or jagged, or more or less round and smooth; next, upon the specific gravity of the material; next, the coarseness or fineness of the material. Hard, heavy and angular pieces will soon imbed themselves into the surface of the tie; they will

hold the tie firmly, and it is only necessary to carry the natural slope of the side of this ballast a short distance beyond the end of the tie to insure a sustaining power to the very end of the tie. With material which drains poorly, the ballast must be left open at the end of the tie, or the tie will churn itself down. When the material is fine, light and drains well, there is not sufficient hold on the tie to keep it in line without having considerable ballast at the end of the tie carried out to some considerable distance, and, in some cases, there is a churning in which the air acts in the same manner as does water in ordinary cases of churning in wet weather. In such cases the light material is thrown up and out at the sides of the track, and until the tie is buried sufficiently to catch this material and cause it to fall back again and other material to run in and take its place, the surface of such light ballast is soon destroyed.

If the purpose of this report was to determine what constitutes an ideal ballast, it would be of very little value. Every road has within its reach certain kinds of material and certain means, and the problem to be decided in each individual case upon its own merits is what available material could best be used, and where to get the best results from such use, and it is with that idea in view, among others that form this report, that the report is presented.

We have not attempted to enter into the question of quarrying, washing, loading or distributing ballast, nor the manner and time of putting it under the track. The available time of the Committee to devote to this work was very limited, and we feel that we have by no means done the subject justice.

Respectfully submitted,

E. HOLBROOK, Kansas City Southern Ry., Kansas City, Mo., *Chairman*;  
F. A. MOLITOR, Choctaw, Okla. & Gulf, Little Rock, Ark., *Vice-Chairman*;  
H. U. WALLACE, Illinois Central R. R., Louisville, Ky.;  
C. B. HOYT, New York, Chicago & St. Louis, Bellevue, O.;  
JOHN V. HANNA, St. L. & S. F. R. R., Springfield, Mo.;  
*Committee.*

President Kittredge:—The report of the Committee is before you, and in order to save time we will consider that the report is open for discussion immediately. We will be glad to have Mr. Holbrook, as chairman of the Committee, make any remarks which he wishes to make in connection with the presentation of this report, and when Mr. Holbrook has finished his remarks the report will be open for discussion.

Mr. E. Holbrook (Kansas City Southern):—I do not believe that I care to make any remarks on the report.

President Kittredge:—The report is before you for discussion. The Committee have not put their report in the form of

any special recommendations for adoption, but they have subdivided the subject into the heads of "Material," "Ballasting," "Depth of Ballast" and "Ballast Cross-Section." It would be advisable to take up the discussion on each one of these in order. The discussion at first will be on "Material." We will be glad to hear from the members.

Mr. H. C. Phillips (Santa Fe):—In the matter of material, the use of burnt clay is spoken of. Can any member of the Committee give me the weight, per cubic yard, which that averages? The reason I ask is, that we have used burnt clay which has run as low as 1,800 pounds per cubic yard. We have not had satisfactory results with it. We are led to believe that other roads are using heavier clay and that it is working well.

Mr. W. E. Dauchy (Chicago, Rock Island & Pacific):—In regard to burnt clay ballast, we have had considerable experience in using this material for ballast, and from such experience we find that if the material from which the ballast is made is of the right character, it makes an excellent ballast; but if the material is not of the proper character, the results are far from satisfactory. The nearer we can come to getting pure clay or gumbo from which to make ballast, the better the ballast is. As to the weight of ballast, it usually runs about 1,600 or 1,700 pounds per yard. I notice an item in the report with reference to burnt clay, which states: "Clay containing little sand and a sufficient quantity of fluxing material to produce a semi-vitreous mass has undoubtedly made a fairly good ballast." I do not want to criticise the Committee, but I do not know where they got their experience in regard to that. It is contrary to our experience with burnt clay ballast. The fact that it has any sand in it at all usually destroys its virtue for the purpose for which it is intended. The cause of all the trouble we have had with burnt clay ballast is this question of sand. We have frequently thought we had a good pit that would make excellent ballast, and we would start with it, and then run across a little streak of sand that seemed to vitiate the whole thing.

Mr. E. E. Hart (New York, Chicago & St. Louis):—In 1893 and 1894 I was Division Engineer on the Southern Division of the Burlington road. I had charge of burning three pits—one at Table Rock and two on the main line near Hastings. The pits near

Hastings were pure clay, with no vegetable matter in the clay. The one at Table Rock was composed of clay and washings from the Nemaha River. The two pits near Hastings did not give the quality of ballast which we obtained from the one at Table Rock. We thought it was due to insufficient burning. I suppose that the coal did not furnish enough heat to burn it thoroughly, while the Table Rock pit was full of vegetable matter, such as leaves, which were washed down by the river and deposited in the clay or gumbo. This pit gave first-class ballast, vitrified, red and hard. I understand they have since burned another pit of 100,000 yards of this same material at the same place.

President Kittredge:—Mr. Hart, can you tell us anything about the weight of the ballast?

Mr. Hart:—We made a record of the weight, but I cannot give it to you offhand. We weighed many cars of it, and the Chief Engineer of the Burlington can give you the weight, as it is on file in his office.

Mr. F. H. McGuigan (Grand Trunk):—During my connection with the Wabash lines west of the Mississippi River, I had charge of burning something over 1,000,000 cubic yards of clay for ballast. Our experience there was similar to that described by Mr. Dauchy. We found that where there was any considerable quantity of sand, we got a poor ballast, as the sand had a tendency to smother the fire. We got the best results from an almost pure clay, or gumbo, that appeared and felt a good deal like shoemaker's wax when you handled it. Our greatest difficulty was in trying to hold contractors to our specifications, which required that each ton of slack coal should burn 5 cubic yards of ballast. The result was that there was not sufficient coal to burn the clay well. We eased off on the specifications a little and got an average, for one year, of 4 2-5 yards of very good ballast to each ton of coal. We ballasted very heavily, using an average of 3,000 cubic yards to a mile of single track. Our weights averaged from 1,550 to 1,675 pounds per cubic yard; the latter was the heaviest ballast we weighed. I should say 1,625 pounds would be about the average. We found that where the ballast was well burned it gave very good results. On curvatures above 3 degrees it was a little light, but it held the track in line fairly well. On curves 3 degrees and under we did not have any trouble.

When the track settled we had 10 inches of ballast all the way through, with a heavy shoulder for the purpose of retaining the line. The well-burnt ballast was lighter than that which was poorly burned.

Mr. W. M. Camp (Railway and Engineering Review) :—I would ask Mr. McGuigan concerning the quality of coal which burned 4 2-5 cubic yards of ballast to a ton of fuel.

Mr. McGuigan:—We used slack from ordinary bituminous coal—simply the refuse. On a few occasions, in wet weather, we used a little run-of-mine coal to bring the fire up.

Mr. W. L. Breckinridge (Chicago, Burlington & Quincy) :—Contractors generally do not put enough coal on the fires, and when but one ton of coal was used to burn 5 yards of ballast, the result was poor material and the railroad company was the loser in the end. Experience leads us to expect one ton of coal to burn 4 yards well. We have contracts in force for 250,000 yards. Pits are selected where there is no sand. The ballast from bottom lands, when free from sand, is of good quality, large size and bright red color. From higher lands it burns a paler color, does not look as well, but is probably as good as the other.

Mr. W. B. Poland (Baltimore & Ohio Southwestern) :—I would ask Mr. McGuigan what the average cost of his ballast is per yard?

Mr. McGuigan:—That question is like many others; it depends on the locality and the conditions. The price of the coal at the mine and the distance you have to haul it; the depth of the clay for burning; the expense of draining the borrow pit, etc., cause the price to vary. When we first contracted our burning the total cost was in the neighborhood of 90 cents a cubic yard, delivered alongside the track. Within three years we made a contract as low as 21 cents a yard for burning. It would be somewhat difficult to strike an average at that time; but in the vicinity of the Missouri River, where the distance is not too great for hauling coal, it should now be burned pretty close to 20 cents a yard in the pile.

Mr. Hart:—On the Burlington road at Table Rock it cost about 24 cents for burning, and 95 cents under the track, with a haul not exceeding 40 miles.

Mr. Poland:—I would be glad to hear some figures as to the relative cost of maintenance of track on burnt clay, as com-

pared with other forms of ballast, if such a record has been kept by any gentleman present. I think the life of the ballast in connection with that would be an important thing to mention.

Mr. McGuigan:—The cost of maintenance would depend a good deal on the locality and conditions and character of the roadbed on which the ballast was deposited. I would say that the general cost of caring for a track would be similar to the cost of caring for it if ballasted with locomotive cinders. If you know what that costs, you can tell what the other would cost. So far as the life of the ballast is concerned, I do not think there is any road which has been using it long enough to determine the life. The Burlington people began using it in 1884, I think, and are still using it. Its average life, under the ordinary traffic of our lines in this section of the country, would be from 12 to 15 years.

Mr. Camp:—I recently saw some figures comparing the cost of renewing ties in burnt clay and broken stone ballast, and the cost per tie was 60 per cent greater in broken stone ballast than in burnt clay.

Mr. C. S. Churchill (Norfolk & Western):—I want to ask if, as a matter of opinion, the Committee have placed these materials in the order of value. I understand not; but if it is the case, I object to that order.

Mr. Holbrook:—There was no intention to arrange it in that way. Before we get off the point, I would like to correct a wrong impression, which is perfectly natural from the reading of the report, and that is, what was meant in the report was that in order to get a burnt clay ballast that was suitable, the quantity of sand would have to be small, and I think it has already been brought out that in some cases there is a good burnt clay ballast which has sand in it. But I think, from all the information we can gather, that in such case the amount of sand is small, and there is some other material which, to a considerable extent, must flux with the sand during the process of burning, so that there will be practically no free sand left. Now, I suppose that the quantity of sand that might be there, and yet produce good ballast, depends largely on other ingredients that are in the clay.

President Kittredge:—Is there to be any discussion on the other portions of the report?

Mr. W. C. Cushing (Pennsylvania Lines):—Under the article on "Stone," I would say that I do not believe that hard sandstone, whether wet or dry, having 95 per cent or any other per cent of silica, will make a good ballast. I have seen the hardest sandstone which I believe is in the country anywhere, and I know from experience it is absolutely unsuitable for ballast. I would, therefore, be very sorry to see the Association approve of a ballast of that kind, provided the general experience of the rest of the members is the same as mine has been with reference to it. I therefore make a motion that the words, "Hard, dry sandstone, having over 95 per cent silica," be stricken from the report.

Mr. Churchill:—A matter like this is far-reaching, and it is too far-reaching to adopt without considerable attention being paid to the question. I will grant that statement applies to sandstone in Ohio and Indiana, and perhaps to parts of Western Pennsylvania, but it does not apply by any means to all sandstone. The Committee has correctly stated the proposition when it makes it depend on the silica contained therein. I have seen sandstone that comes close to conglomerate rock, than which there is nothing harder. It is hard as any limestone you can get; and the three stones—the trap rock, the hard limestone and the very glassy hard sandstone—make first-class ballast. We have in use both the sandstone and the best limestone, and I have used the trap rock, and I know that there is no choice between the two—a good quality of limestone and a hard sandstone. I am not talking about yellow sandstone, freestones or anything of that kind. I mean the real hard sandstone, that will cut and produce a glassy surface. I think the report of the Committee is right in naming the sandstone, with certain restrictions, and the same thing applies to everything else that they have named; gravel, slag and everything that is used must be a selected article to get the best results.

Mr. Cushing:—It does not make any difference how hard sandstone is. It is the way it wears. It wears round, which is one of the troubles with sandstone ballast. Limestone wears and chips off and leaves a sharp edge, or does more so than a sandstone ballast. While sandstone may be exceedingly hard in itself, it is the way that it breaks and the edges wear off that spoils it for ballast.

Mr. McGuigan:—I agree with Mr. Churchill, that the Committee is correct in placing sandstone among the other varieties of stone for ballast. I also agree with my friend from the Pennsylvania Lines, that it is not the best stone, but there are sections of country where there is no other stone available, except different varieties of sandstone, and I can see no advantage in saying that it is not fit for ballast. The form in which sandstone breaks, as a rule, makes it somewhat objectionable; it does not break in cubes, as the harder stones do, but is inclined to chip off, and does not work as nicely, nor hold the track in line so well. It does, however, make a fairly good ballast, and certain roads are almost compelled to use it, as they have no other ballast available, and for that reason I believe the Committee is justified in including sandstone.

(Motion not adopted.)

Mr. Hunter McDonald (Nashville, Chattanooga & St. Louis):—For the purpose of bringing out discussion on the subject, I move that on the second page there be added at the end of the first paragraph the words, "Gravel containing a considerable amount of sand should be screened."

Mr. Phillips:—Is there any mention whether the gravel is water-washed gravel, round gravel or angular gravel?

Mr. McDonald:—I think the point the gentleman makes is well taken. The motion should include water-washed or round gravel. I find when it has a large mixture of sand it will not hold the track. Some have a sharp gravel that will hold, although the sand is in it. I made the motion in order to get an expression from the house as to that question.

President Kittredge:—You accept the addition of the words "water-washed?"

Mr. McDonald:—I accept.

Mr. D. W. Lum (Southern Railway):—It seems to me "water-washed" gravel will be composed largely of smooth, round stones, and it would be impossible to keep it under the ties.

Mr. Samuel Rockwell (Lake Shore & Michigan Southern):—I have a half dozen gravel pits on the Lake Shore road, and I have taken samples from all of them and separated the sand in one pile and the gravel in the other pile, and there is just about 50 per cent sand. We hold our track pretty well with that kind of

gravel. We would as soon have rather less sand, but we manage to hold the track all right with it as it is.

Mr. Cushing:—The use of screened gravel so far has been very successful indeed. It has been noticed in wet weather that a track put up in screened gravel keeps its surface better than the track that is put up with gravel with a large admixture of sand, amounting to about 50 per cent at least. The gravel varies so much in its size that the very small particles of the gravel are sufficient to cause the rest of the gravel to pack pretty well together. The small particles and the large pieces mingle well together and hold up very well.

Mr. Lum:—Is that angular gravel or round gravel?

Mr. Cushing:—It is round gravel; the usual gravel from banks above present river bed, not crushed at all. The cohesion is due to the fact that there are a large number of small particles of gravel, which might be considered as exceedingly coarse sand, mixed in with it, to bind it together. If they were all of a uniform size, I do not believe they would answer very well.

Mr. McDonald:—The idea I have always had in regard to the trouble with gravel is that the sand, when it is first put in with the gravel, will not go to the bottom. It remains all through the voids, but as soon as the rains come on it the sand washes to the bottom and makes the whole roadbed settle. Of course, if the gravel is of uniform size, it would not do it so much as when intermixed with fine sand, which runs to the bottom. A sharp sand would not, possibly, be so bad, but my belief is that the fine, round sand should be screened out of the gravel if you want to maintain a good track.

President Kittredge:—The Lake Shore people have said that they have a sand and a gravel mixed in about equal parts; that is, about 50 per cent sand.

Mr. McDonald:—I presume their sand must be coarse, and in order that that point may be thoroughly covered, I would substitute for the words "considerable amount" the words "30 per cent."

Mr. Rockwell:—If you are going to condemn all gravel which has more than 30 per cent of sand, you will condemn all the gravel used on the Lake Shore road.

Mr. McDonald:—I understood the Lake Shore was screening the gravel which it used, and that was one of the reasons which impelled me to bring up this point.

(By letter)—I would refer the members to the discussion on this subject at the first annual convention.

Mr. Rockwell:—We have not screened any gravel at all.

Mr. McGuigan:—I think if you condemn any gravel with more than 30 per cent of sand you will not only condemn the gravel used on the Lake Shore, but the gravel used on nearly all the other railroads. Our experience with water-washed gravel is that it holds the track better with the sand in it than if the sand is taken out. I have not had much experience with the screening of gravel, but we have some gravel taken from the north shore of Lake Erie, and I am quite well satisfied it would be difficult to hold the track if the sand was taken out by screening.

Mr. Phillips:—I do not think, without specifying more accurately the size of the gravel which we have in mind, that we can give an intelligent decision on the subject of sand, for the reason that while the sharp gravel would hold better than the stone does, a round, water-washed gravel would give a ball-bearing under our ties, which is exactly the condition we are trying to avoid. I think, therefore, we should not put in this report any certain percentage of sand, without specifying whether the main particles are either round or angular.

Mr. Churchill:—Mr. Cushing made a point in his remarks. He said that although he screened his gravel, still there was sand in it. Can we not get at the bottom of this matter by asking the size of the sand left in the gravel? I think it is possibly the seat of the trouble—the coarseness of the sand.

Mr. Cushing:—The way our gravel is obtained is this: There is a sand company which screens this gravel for the purpose of obtaining the sand for commercial purposes; that is, all the sand is taken out of it—such fine sand for commercial purposes as is sold for building operations and various kinds of industries, glass plants, etc. The remainder is taken by the railroad company and used exclusively for the ballasting of the branch line on which the company is located which screened the sand, and there has been a noticeable increase in the quality of the track

on that branch since we have used the screened gravel ballast. In connection with the water-washed gravel, there is a piece of road which the Baltimore & Ohio has between Newark and Columbus which is ballasted with what may be considered water-washed gravel, which is dug directly from the bed of the creek or river, and they have been enabled to maintain an excellent track on that piece of road. I have been familiar with it for a long time. It therefore seems to me we are really getting into hair-splitting again, when it comes to the discussion of this sand question. It is a difficult matter for us to say just how much sand is injurious to the ballast. I feel that a large proportion of sand is injurious to ballast. I believe from what I have seen that an excellent track can be kept up on washed gravel at economical cost, and a most excellent track can be maintained on screened gravel, screened in the way in which I have mentioned.

President Kittredge:—We will now take a vote on the amendment that "Gravel containing as much as 30 per cent of sand should be screened."

(The amendment was not adopted.)

Mr. C. Lewis (Baltimore & Ohio):—I would ask if the Committee has considered the question of defining the difference between a sand and a gravel, which question arises quite frequently. It would be very convenient if some arbitrary division point, establishing the difference between sand and gravel, were determined. The usual method is to reject stones over a quarter of an inch in diameter for sand. I have not seen any written statement of it, and I thought it would be in order to ask the Committee to say whether they consider that a satisfactory dividing point between coarse sand and fine gravel.

Mr. Holbrook:—The Committee has made no attempt to draw the line between coarse sand and fine gravel.

President Kittredge:—If there is no further discussion under the head of "Materials," we will pass on to the second sub-heading, "Ballasting."

Mr. Camp:—I think that in this paragraph on "Ballasting," the Committee has touched on some of the most important points of track support. About the middle of the paragraph it states: "The requirements of the subgrade or roadbed are that they should of themselves drain freely," etc. One of the functions of ballast

is to drain freely, but in draining the water through the ballast we have not by any means gotten rid of it. If you have a roadbed with a sloping top, on which the material is well packed, the water will drain off under the ballast, and I think that is the ideal condition. If, after a hard rain, you go along and observe track that is laid on such a roadbed, you will see the water trickling out under the shoulders of the ballast. But if you have a saucer-shaped roadbed, the water is going to seep down through it, and that roadbed will continually settle. I think it might be well if the Committee on Ballasting and the Committee on Roadway would take up this matter conjointly, and consider the proper treatment for the top of the roadbed. In the report on Roadway, presented yesterday, the Committee states that it does not think it worth while to recommend crowning the top of the roadbed, for the reason that such work is nearly always neglected in construction, and the Committee seems to think that the shoulders will settle more rapidly than the center of the roadbed, anyhow, and that the result after a number of years will be that the roadbed will assume a crowning contour naturally. I do not think that is always the case. At any rate, the practice on some roads is to cut down the shoulders in order to drain the water from the middle of the roadbed. I do not think it is always practicable to treat the top of the roadbed the way in which it should be treated. For instance, in filling in a trestle, it is hardly practicable to do that, but in making an embankment with teams I think it is an easy matter to so perform the work that the top of the roadbed will shed water. If the material that is dumped into the embankment is kept higher in the center than on the edges, and the teams driven continually over the center of the roadbed, when the embankment is finished, the center of the roadbed will remain higher than the shoulders, permanently. I think this is the ideal condition, that the center of the roadbed should be higher than the shoulders and packed as well as it is possible to do it.

Another good point the Committee touches upon is in reference to sub-ballast. I want to call attention to the practice of combining two kinds of material in ballasting. It is pretty generally conceded that stone ballast affords the best bearing of any of the ballasting materials. But it is costly to work in. In renewing ties it usually costs from 40 to 50 per cent more to make

the necessary excavations for taking out the ties than it does in other kinds of ballast. Now, if you have stone ballast under the ties and gravel ballast for filling, you have the best quality of material that is obtainable for bearing and a material for filling that is cheap to work in. This has been tried to a considerable extent. I know of an instance where stone ballast has been used for bearing and gravel for filling, and another case where slag ballast was used for bearing and cinders for filling, and it is not an expensive matter to arrange the ballast that way. When the track is first laid it is ballasted with broken rock, and after that settles it usually needs surfacing. The track is then raised an inch or two to get the ties high enough above the rock ballast so that you do not need to dig into the rock ballast in renewing ties. The track is then tamped up an inch or two on the gravel and filled in with gravel.

Mr. Dauchy:—I agree with what the gentleman has said about the desirability of putting lighter material on top of stone ballast. We have followed that practice quite extensively and put cinders on the stone ballast, particularly where the stone is of an inferior quality. It makes a track more economical to handle, both in maintaining the surface and in renewing the tie. I think it is a good point to be brought up.

Mr. Holbrook:—I want to mention a single instance that came under my observation. My attention was called to it by the track supervisor. He told me in a certain place he had three feet of stone ballast, and yet the mud was still pumping up around the ties. That was an instance where the embankment was of such material, so light and so poor in its draining qualities, that the stone naturally worked continually down through it, and had done so for a dozen years, and it was still going on. I have known other cases, not as marked, perhaps, as that, where stone ballast did not give a support; where it simply kept moving down by its greater specific gravity and by the pressure on it, and the natural material of the embankment or cut kept coming up through it. I know that in some cases of that kind the embankment has been dug out and some other material put in there which would stop that action. In other cases it seems to me that very heavy rock, put in where there is a large bearing surface on a single piece, does that same work. In the cases that I have mentioned,

of course, there is a cave or depressed place right in the middle of the embankment. The water runs all through it and stands in the cavities between the stones and siphons the material underneath, and the action goes on indefinitely.

Mr. McGuigan:—I think the trouble in that case is with the roadbed. With reference to combining gravel with stone, there is no question but what it will reduce the cost of tie renewals, and possibly you can maintain a smoother riding track at less cost. I am inclined to believe you can, but most roads that use stone ballast are roads with a large traffic and earnings. Mr. Torrey here reminds me that gravel on top of stone ballast produces a good deal of dust, which roads with a freight traffic would not mind; but I question whether it would be a wise practice on roads having a large passenger traffic to put gravel on top of the stone. Stone ballast, as it is being used on the better class of roads to-day, is so fine and so easy to handle that the cost of tie renewals is reduced 25 to 50 per cent, compared with what the cost of renewing the ties would have been eight or ten years ago with coarse stone. I would not regard it as good practice, on a passenger line, to put gravel on top of stone.

Mr. Dauchy:—My practice has not been to put gravel on top of stone, but to use cinders in such cases. We have found that to be very good practice and have had excellent results from it. The dust question did not enter into it.

President Kittredge:—We will now take up the question of ballast cross-section.

Mr. J. A. Atwood (Pittsburg & Lake Erie):—I move to strike out the words "eight to" and make the paragraphs on rock ballast read: "Depth below tie, 12 inches," and also to insert after the word "at" the words "a point 8 inches from the end of the tie," so that the sentence will read: "Rock Ballast.—Depth below tie, 12 inches; top surface of ballast, top of tie; slope of ballast, from top of tie, at a point 8 inches from the end of the tie, to subgrade, at the rate of  $1\frac{1}{4}$  or  $1\frac{1}{2}$  to 1."

President Kittredge:—These are separate questions, and we had better act on each one independently.

Mr. Atwood:—I make a motion to strike out the words "eight to."

Mr. Lewis:—Would it not be in order to submit an amendment of that kind to the Committee for consideration?

President Kittredge:—The Association desires to act on such matters as it can get together on, and where it can do so it is preferable to have them acted on and decided, but where there is any question, or where the subject is deemed worthy, it can be referred back to the Committee for further consideration.

Mr. Rockwell:—I take it that the depth of ballast required depends upon the roadbed underneath. A very hard roadbed requires little ballast, just enough to embed the ties and give material enough to work with. I have some rock ballast under track tanks. There is 5 feet of ballast under some of them now, and it is still going down.

Mr. Holbrook:—The only point the Committee have in mind in making that as it is, is that there is a great deal of stone ballast put in where there is already some other ballast, where there has been gravel and the track has been used for a good many years and where it may be very hard. In that case it seems to me, particularly on a road with comparatively light travel, that 8 inches may be sufficient, using 8 inches as a minimum under the most favorable conditions.

Mr. W. J. Harahan (Illinois Central):—I think we should leave it at 8 inches. Upon a great many lines the conditions are such that 8 inches is sufficient ballast, not only on account of the traffic but on account of the roadbed. Eight inches of ballast under these conditions will sustain the traffic, and I think the Committee is right.

Mr. McGuigan:—I am disposed to agree with the Committee. I also, in a measure, agree with Mr. Rockwell, that conditions must govern, although I do not agree with him that on a hard roadbed you should reduce the quantity of gravel, as a greater quantity is required for a cushion in rock cuttings or hardpan. I would reduce the quantity on a firm, porous material, where the drainage was good, or on a sandy embankment which has sufficient adhesion to hold its form, but I would put more gravel in a rock cut than in a clay cutting which would drain well. I think the recommendation of the Committee is fairly good.

Mr. Rockwell:—I do not mean to say that on a hard roadbed we do not need ballast enough to thoroughly embed the ties and make the track elastic, but 8 inches would ordinarily be enough for that.

Mr. McGuigan:—I think not, in some cases. I think our Pennsylvania friends will bear witness to the fact that in some rock cuttings they ballast pretty heavily.

Mr. Cushing:—What Mr. McGuigan says is true. It is so extremely difficult to make a good cut that it generally takes an average depth of ballast to make it satisfactory. A small amount of ballast will not allow the proper adjustment of the track, and I am in favor, even in rock cuts, of the full amount of ballast up to 12 inches, and even 14.

Mr. Atwood:—My recommendation to make it 12 inches below the ties is based on the fact that in actual practice we do not get a roadbed filled exactly to the uniform subgrade, and consequently there are places where it is either high or low, and in order to get a ballast that is going to give satisfactory results, I think 12 inches is small enough to allow for these inequalities. I think the 8 inches should be stricken out.

President Kittredge:—I think it would be better to substitute 6 inches for 8 inches. I know of one road—without mentioning names—which is pleased to get 6 inches of stone ballast under its track where it has to haul the stone 100 miles. If there is no more discussion, we will put the question to eliminate the words "eight to" in the first line of the paragraph beginning "Rock Ballast."

(The motion was not adopted.)

Mr. Atwood:—I move that the paragraph be changed to read: "From top of tie at a point 8 inches outside of the end of the tie."

Mr. D. W. Lum (Southern Railway):—I am in favor of the report of the Committee that it is not necessary to extend the ballast beyond the end of the tie at the top.

Mr. McGuigan:—Is not Mr. Lum using a 9-foot tie?

Mr. Lum:—We are using a tie  $8\frac{1}{2}$  feet long.

Mr. McGuigan:—Would you treat that exactly as you treat an 8-foot tie? Would you form the shoulder exactly the same for an  $8\frac{1}{2}$  or 9-foot tie as for an 8-foot tie?

Mr. Lum:—I would treat an  $8\frac{1}{2}$ -foot tie the same as a 9-foot.

Mr. McGuigan:—I ask if you would give an  $8\frac{1}{2}$  or 9-foot tie the same treatment as an 8-foot tie? Most roads are using ties 8 feet long, and on such roads I believe it will be better to

extend the shoulder a little wider. The heavier power and heavier rolling stock which are in use to-day require a heavier shoulder than was used some time ago. I think the report is correct in that respect.

Mr. Lum:—My idea is that the shoulder at the end of the tie is not necessary.

President Kittredge:—Is there any further discussion on the amendment to make the slope begin 8 inches outside of the end of the tie at the top?

Mr. Phillips:—In practical track work you cannot always support a work train for every mile of track for every year, and after the ballast is once placed and the shoulder formed, it will be a certain number of years before the ballast can be redistributed, and during that period the shoulder will not be up to standard.

Mr. Lum:—That would be making your standard and departing from it at once.

(The amendment was put to vote and was adopted.)

Mr. E. E. R. Tratman (Engineering News):—Under the head of "Chatts," the report says: "Top of slope, 6 inches beyond end of tie and even with the end thereof." Should not that be even with the top thereof?

Mr. Holbrook:—It should be "at the top thereof."

President Kittredge:—The question on the acceptance of the report of the Committee as a whole, as amended, is now before the house.

(On motion the report was adopted as amended.)

Mr. Poland:—Before the Committee is discharged, if it is in order, I would like to suggest that in presenting their report another year they present to the Association the diagram of cross-section which they recommend for various styles and kinds of ballast. In doing that they should consider different classes of track. The discussion that has been brought out this morning on stone ballasting seems to show that we should have more than one kind of stone ballasted track. We should have a diagram of the cross-section which would be required under a very heavy traffic, and we should have a diagram of the cross-section for a much lighter traffic. I think that would apply to almost every style and kind of ballast. The cross-sections should be sent out in time, so that they can be thoroughly discussed by the members

when the diagrams are presented to the meeting. I make that as a motion.

(Motion adopted.)

Mr. W. M. Camp (By letter) :—The Committee recommends that where light sand is used the tie should be buried in the ballast, or that the ballast should be filled in "above the top of the tie at the end, and even carry the top of the ballast some distance beyond the end of the tie before starting the slope." The practice of dressing ballast higher than the top of the tie, or over the top of the same, next to the rail seats and outside the rail, is objectionable for several reasons. In the first place, the grit will work into the rail seat, and unless tie-plates are used the rails will cut into the ties and neck the spikes badly. If tie-plates are used, the sand and dirt will work under the rails and cause excessive wear on the plates.

Another difficulty where the ballast is higher than the tops of the ties at the rails, at least in northern districts, is the hindrance of such material to the work of shimming. In ballast of the character stated, the track is quite liable to heave when the ground freezes, and a good deal of shimming must be done during the winter months. If the ballast is filled in as recommended by the Committee, the rail will lie in a rut with frozen material on either side, and the work of picking this out in order to properly insert the shims is an expensive and tedious operation. A section crew would make but very slow progress at shimming on such track.

The Committee states that unless the ties are buried in the ballast, the sand is liable to blow out. On some of the railroads of Mexico where this difficulty arises a shallow layer of broken stone is spread over the track and shoulders to protect the sand ballast from the wind. I am not aware that this method has been tried to any considerable extent in this country.

President Kittredge:—The Chairman of the Committee on Buildings, Mr. H. W. Parkhurst, of the Illinois Central, will present the report of that Committee to you.

## REPORT OF COMMITTEE No. VI.—ON BUILDINGS.

*To the Members of the American Railway Engineering and Maintenance-of-Way Association:*

The Committee on Buildings have selected from the topics assigned to them two subjects for consideration at the annual convention of 1902. These are the topics numbered "6" and "9" in the general schedule, namely, "Coaling Stations" and "Water Tanks."

## COALING STATIONS.

A "Coaling Station" or a "Coaling Plant" is a name applied to the appliances and conveniences which may have been adopted for supplying locomotive tenders with coal. In its broader sense, it includes tracks, storage bins, derricks, hoisting engines, coal chutes, and all machinery connected with taking coal from cars in which it is shipped, and placing it in store for future use, or for delivering it either directly from the coal cars or from store to the engine tenders.

The methods by which this work is accomplished are exceedingly various, and depend on a great variety of conditions which present themselves under different phases and combinations, and render the true solution of the economic equation almost impossible.

The principal factors for consideration may, however, be enumerated as follows:

*First.*—The question of location is one of the most important for consideration. This will be governed by the convenience as to the operation of the business of the railroad. At terminals and at junction points, it is probable that large coaling plants will be desired; but at intermediate points on the line, coal must be supplied to locomotives hauling freight and passenger trains. The location may determine largely the nature of the plant to be used. Where large quantities of fuel are to be handled with only a limited amount of room for the construction of tracks and buildings, an expensive mechanical plant may be fully justified. At other points where land values are small, a totally different style of plant may be the most economical.

*Second.*—The quantity of coal to be handled will also largely influence the character of the plant to be constructed. Where but one or two carloads of coal per day are required, it is doubtful whether anything but the simplest plant should be built that is sufficient to permit delivering the coal required in the least possible time. On the other hand, where from two hundred to four hundred tons per day have to be handled, expensive plants, well designed machinery and first-class construction will be justified.

*Third.*—A third consideration is the cost of operation. This touches upon the labor question, involving the consideration whether steam engineers, machinists and expert mechanics, or crude day labor shall be utilized in connection with the operation of the plant. In some parts of the country, day labor may be had at approximately one-half the rates which are demanded in others. The rate of wages to be paid to the laborer will be an important item.

*Fourth.*—A fourth consideration will be the amount of first cost, and also of the cost of repairs and renewals. It is evident that to make a true

comparison of the economy of different plants, these items should be reduced to a measure of cents per ton of coal handled, rather than to make a comparison of the gross amounts of actual cost and of maintenance.

*Fifth.*—In the same connection, a true comparison will require a consideration of the interest on the cost of the investment, and this also should be reduced to an equivalent value of cents per ton of coal handled.

*Sixth.*—Complicating with all of the above is the question of storage. That this is a matter of great importance, and that it usually receives but little consideration, is evident from the amounts which are annually spent in storing coal on coal cars, and holding the same on sidetracks at coaling stations, rather than constructing suitable storage bins in which the coal may be kept, thus liberating the cars for commercial business.

*Seventh.*—The kind of coal handled will also influence the decision—whether it be anthracite or bituminous, or both, inasmuch as the appliances which are efficient for one kind of coal may be less so for the others.

*Eighth.*—The facilities which each company has for delivering coal to its coaling plants will tend to make the situation more involved, since coal may be handled either in box cars, gondola cars (with stationary or with movable sides or traps), side-dumping or bottom-dumping cars, and other varieties, each of which will have its own influence on the special modification of plant to be adopted for economy.

In order to determine what progress up to date had been made in the solution of this problem, your Committee, with the assistance of the Secretary, prepared a circular, which was sent out to 225 railroads all over the country, requesting information as to the "recent practice in the construction of coaling appliances." A brief statement at the head of the circular calls attention to the desire for information as to the "recent practice," and requests that any systematized or tabulated data which may have been made with reference to the cost of handling and storing coal and the use of coaling plants generally should be furnished in reply to the circular. Then follow questions, numbered from "I" to "II," as to the style of plant in use, which were intended to refer to any recent improved plant in use, and the opportunity was thus given to the engineers of the several roads to whom this circular was sent to give any detailed statement or description that they might be able to furnish as to recent improvements.

A tabular summary of the replies to this circular is given in the following table.

A little over forty replies only were received to this circular, and the general indication was that but little care was taken in filling the blanks, it being frequently understood that an attempt was made to get a description of all the coaling plants in use by any given road, rather than to describe the most recent or most approved plant. Very frequently no information was given as to the actual cost of operation. No questions were asked as to the cost of maintenance and repairs, etc., nor as to the original cost. It was, however, intended to ascertain, so far as possible, the actual cost of operation, and then that this cost should be distributed so that it might be shown whether, beside the labor, fuel, supplies, etc., required in operation of a plant, there were included any items of cost of repairs and maintenance, of interest, etc.



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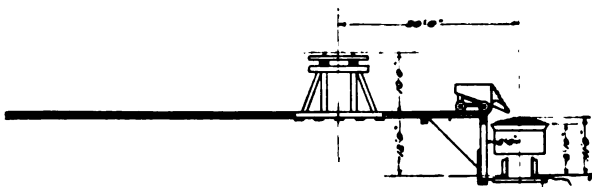
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In general no details were given of the cost. Out of the forty-odd replies received, twenty-eight companies use coal chutes of one or another kind for the delivery of coal to their engines. Twenty-eight get the coal up to these chutes by means of inclines. A few have no better means of coaling tenders than to shovel the coal directly from the cars, or at least this is to be inferred from the fact that they do not list any better method. Less than one-fourth of the whole number have adopted any of the mechanical appliances for handling coal. A large proportion have no improved method for storing coal, and of these not all have any machinery for moving the stored coal either to chutes or to tenders for use. But very few make a practice of storing coal in any large quantities, but depend either upon storage in cars, or small piles placed either upon the ground or upon storage platforms as the only alternative to handling direct from cars through chutes or otherwise to the tenders. The statements of cost, as already alluded to, are very incomplete, and those that are given are somewhat indefinite. The rates named cover a wide range and but little can be learned from the study of the distribution given. It is not made entirely evident that the mechanical appliances for handling coal are always economical; in fact, the least rate at which coal is reported to be handled in any of these plants is where coal is delivered in dump cars, and is dumped directly to chutes, reported to cost only one-half cent per ton for the delivery from cars to tanks or tenders.

Accompanying the replies to this circular there were transmitted a number of blue prints of various types of coaling plants, and the Committee has selected from these certain general types which are illustrated by plates attached to this report and which may be briefly described as follows:

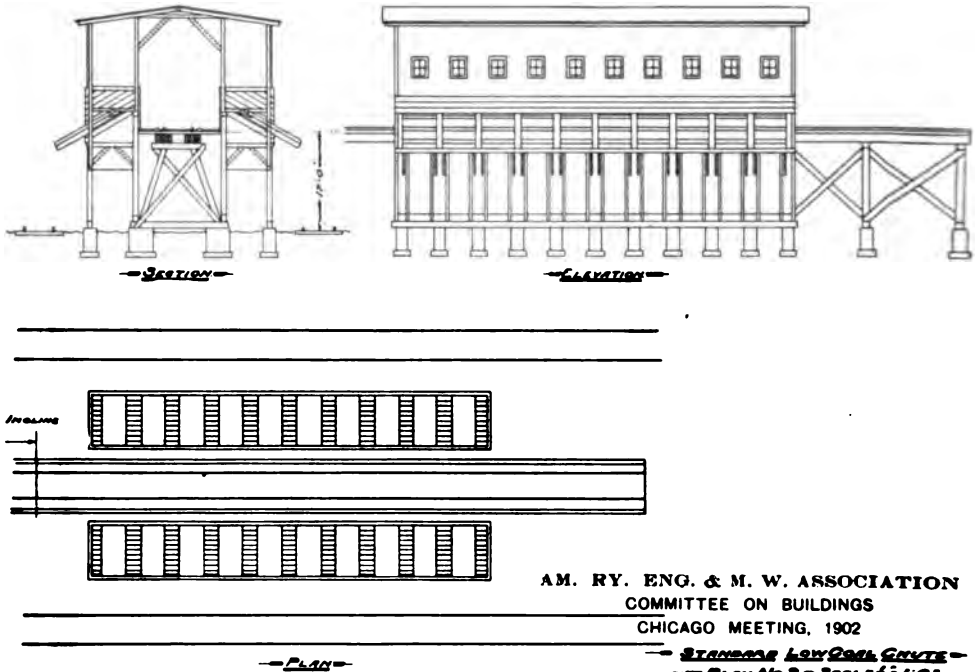
PLAN NO. 1 shows a type in which coal is delivered on an elevated platform. This coal is loaded into barrows, cars or buggies, trucked to the edge of the platform and dumped directly into the tenders, the platform being about the level of the top of the tender. Modifications of this plan of various kinds are shown. One, where the platform is high enough so that the coal may be dumped from the cars or buggies into chutes and



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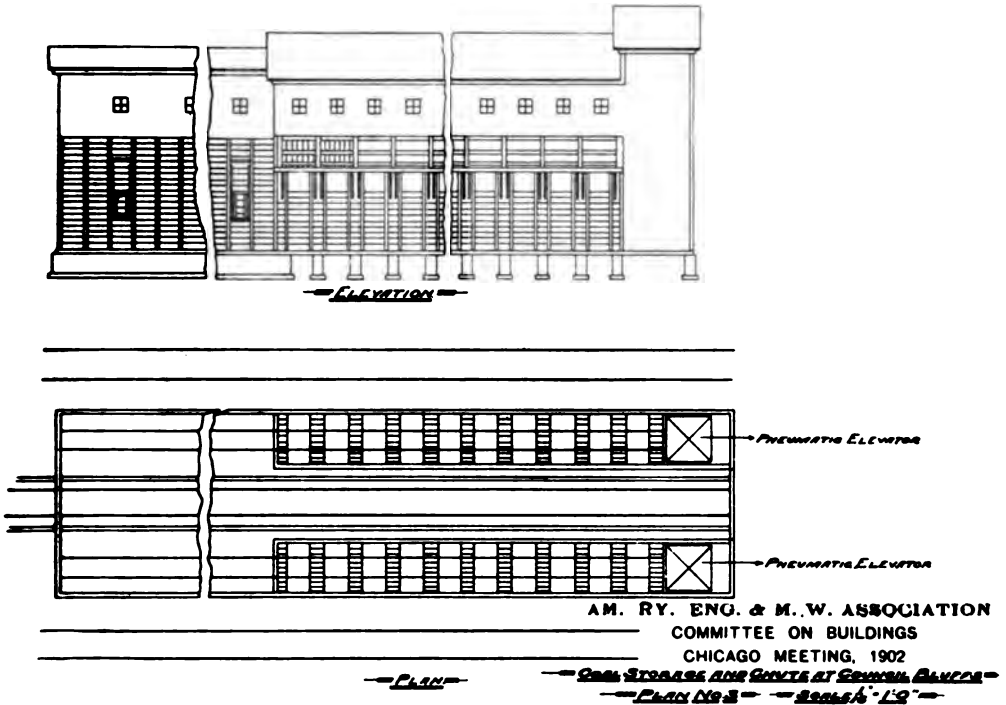
— CANADA ATLANTIC RAILWAY CO. —  
— COALING DEVICES —  
— PLAN NO. 1 — — SCALE 1/2" —

stored until wanted. The chutes have the usual capacity of from two to five tons. Another modification has an elevated trestle on which the coal is received and where it can be dumped by side or bottom dumping cars to the platform. Still another modification locates the coaling plant on elevated ground adjacent to the coaling tracks, and the platform is built directly on the ground. All these plans, however, involve the idea of delivering the coal from the car to a platform which has sufficient room for a greater or less amount of storage, and the coal is wheeled in suitable vehicles and delivered in greater or less quantities to the tenders. The cost of operation of plant of this kind will vary from  $5\frac{1}{2}$  cents upward.



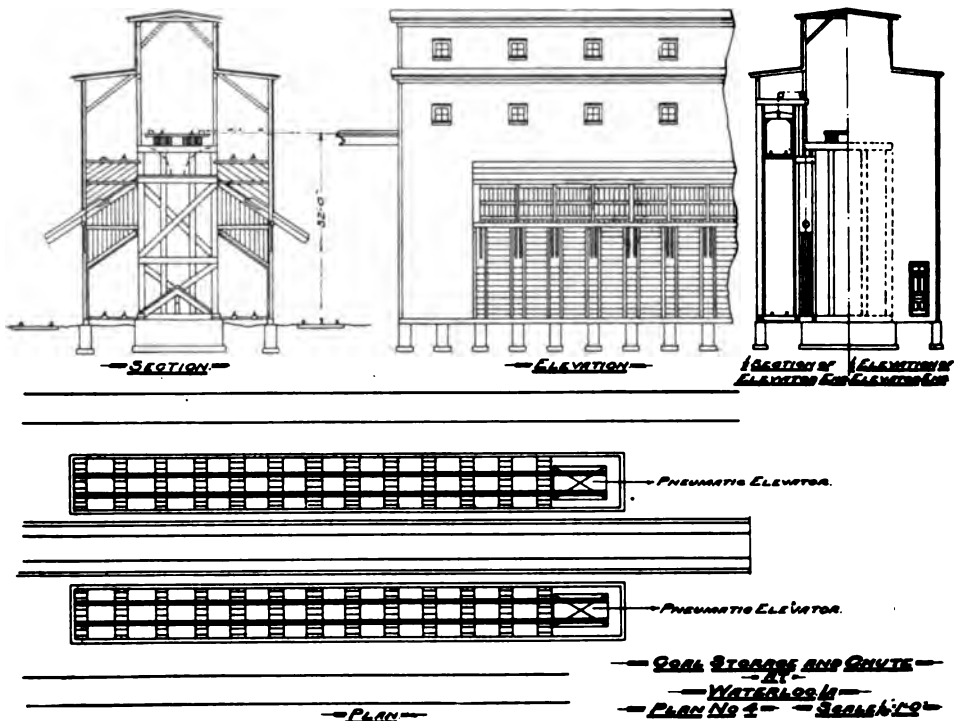
PLAN NO. 2. A type of coaling plant of a little more complex nature provides an inclined track up which loaded coal cars are pushed and from which the coal is shoveled into chutes, either on one or both sides of the track, from which chutes it is delivered directly to the engine tenders. This style of plant provides no storage, and the rate per ton at which it can be operated will depend largely upon the cost of day labor. In the Southern states, where negro labor can be had, coal is handled in this way at the rate of five cents per ton. In the West, where labor is expensive, this cost will be increased to from seven to nine cents per ton, several roads reporting the latter amount as the regular cost per ton for handling coal in this way.

PLAN NO. 3. A third plan shows a modification of the above plan, providing for storage facilities in connection with the coal chutes and giv-



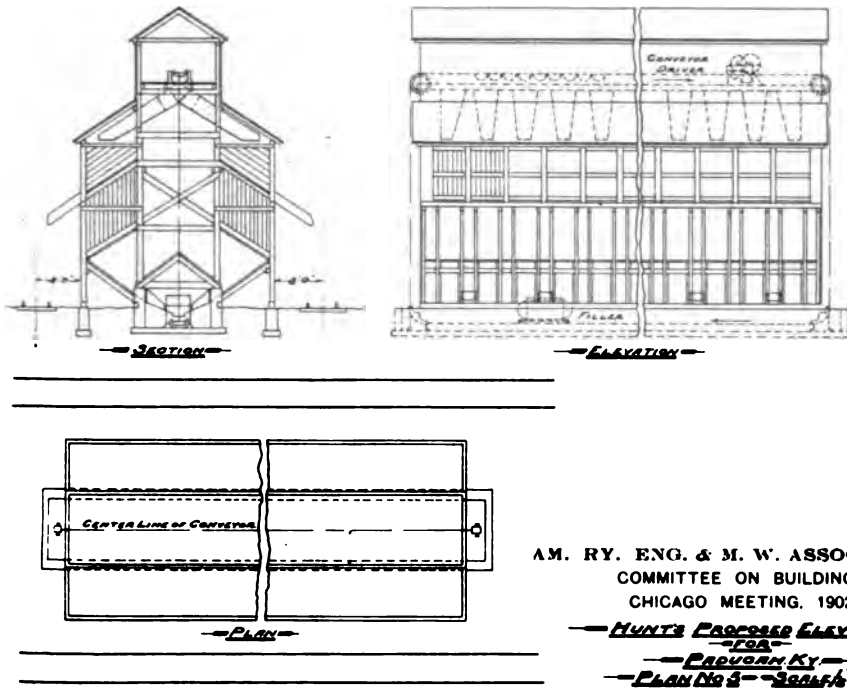
ing suitable means for handling the stored coal. The incline and chutes are constructed essentially as in Plan No. 2, but the lower portion of the building underneath the chutes is housed in, and may or may not be built with inclined bin bottoms, so that any surplus coal which is not needed at once for supplying the chutes may be unloaded into the storage. If coal can be delivered in side or bottom dumping cars for this purpose, the cost of storing the coal will be reduced to a minimum. If it has to be shoveled from the cars to storage, there would be no object in storing the coal except as a provision for emergencies. The means for handling the stored coal consist in the construction of tracks underneath the chutes along each side of the storage pile and the provision of two pneumatic elevators, one on each side of the main track at the end of the building, these elevators to be operated by compressed air, which is made by a combined gasoline engine and compressor and stored in storage tanks. Small bottom-dumping cars of one and one-half tons capacity are loaded with the stored coal on the lower track, pushed to the elevator, raised to the level of the track above the chutes, and then run out over the chutes and dumped, making an extra cost of approximately eight cents per ton for the handling of the stored coal, and of from six to seven cents per ton for unloading the coal either to chutes or to storage. The cost per ton in the whole plant will, of course, depend upon the relative proportions of coal used direct from the cars and coal stored and then used afterward.

PLAN NO. 4. A fourth plan presented shows still another modification of the last-named plan. This was devised to permit the use of side-dumping cars to deliver coal directly from the cars into the chutes; or, if desired, to deliver the same coal into storage. In this modification, the track in the center of the chutes on which the coal is delivered is placed at the end of a long incline, and is approximately thirty-two feet above the level of the main tracks adjacent to the coal chute. This elevation permits the delivery of coal directly into the chutes, provided the trap-doors underneath the center track are raised and held in proper position to make



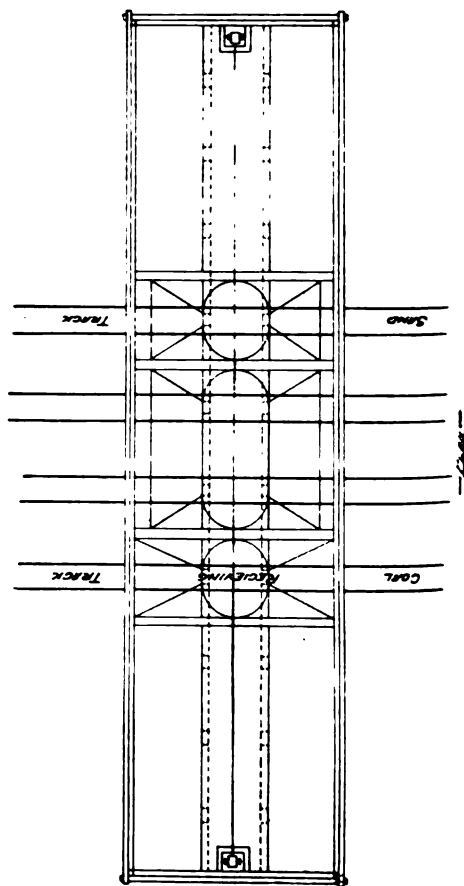
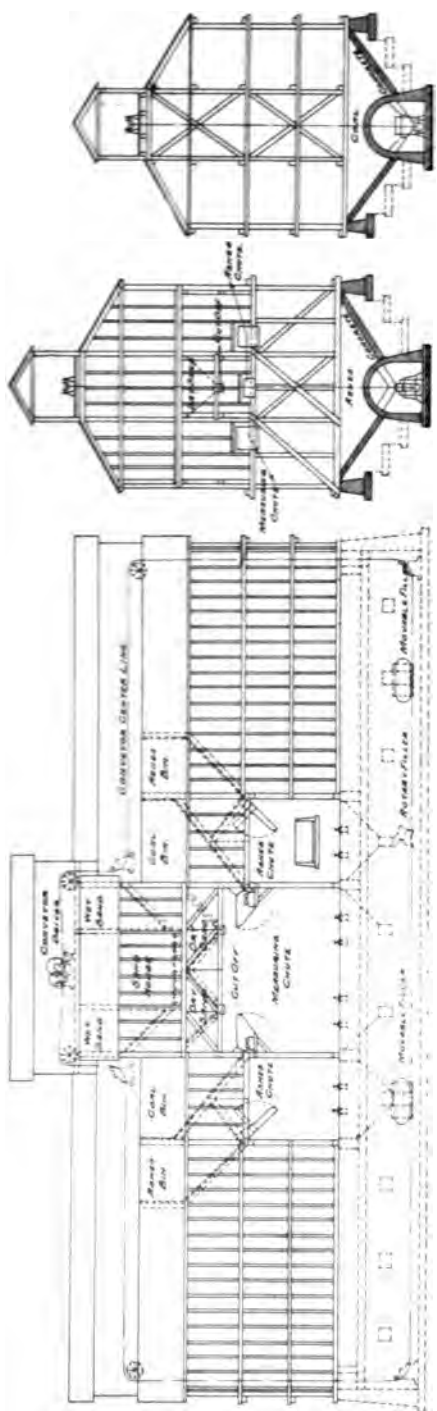
an incline suitable for such delivery. If these trap-doors are thrown over to a vertical position, the coal will drop into storage. The same means for handling the stored coal are provided as listed in the last plan. This style of chute has been in use but a very short time, and no data are at hand as to the cost of operation.

PLAN NO. 5 and PLAN NO. 6. On these two plans are shown designs made by the C. W. Hunt Company, for coaling plants proposed to be constructed for the Illinois Central Railroad Company at Paducah, Kentucky, and at Waterloo, Iowa. In both plans, the coal would be delivered into track hoppers underneath the coal chute building, which hoppers are designed so that the coal may be unloaded either from center-dumping or side-dumping cars, or may be shoveled from gondolas or box



cars. This coal is delivered from the track hopper into a conveyor which extends through a tunnel underneath the building, traveling its whole length. This conveyor is carried up at both ends of the building, and passes from end to end above a series of chutes, into which the coal may be delivered at will, delivering either into the storage bins, from which it is drawn by means of measuring chutes or ordinary coal chutes into the tenders, or it may be delivered into storage, the whole lower portion of the building being used as a storage bin, having a capacity of from 3,000 to 5,000 tons. This storage bin has an inclined bottom, and the coal would be delivered at any one of the number of gates located along the sides of the tunnel through which the lower conveyor travels. This coal would be carried to the conveyors by means of an automatic apparatus. The conveyor, therefore, serves either to store the coal, or to handle the coal from storage to the chutes, or to handle the coal directly from the track hoppers to the chutes. As a side issue, and combined with the coaling plant, the same conveyor also handles cinders and sand.

While neither of these plants have been constructed, the tabulated statement above referred to gives data as to the operation of a similar plant on the Chesapeake & Ohio Railway, stating the cost of handling the coal from cars to tenders directly at two cents per ton. In addition to the above statement, data as to the operation of similar plants are at hand, giving the average cost of handling coal at a large station on the Philadelphia & Reading Railway at slightly over four cents per ton, for



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## CHICAGO MEETING, 1902

**— ЗАДАЧА ПРЕДЪЯВЛЕНА —**

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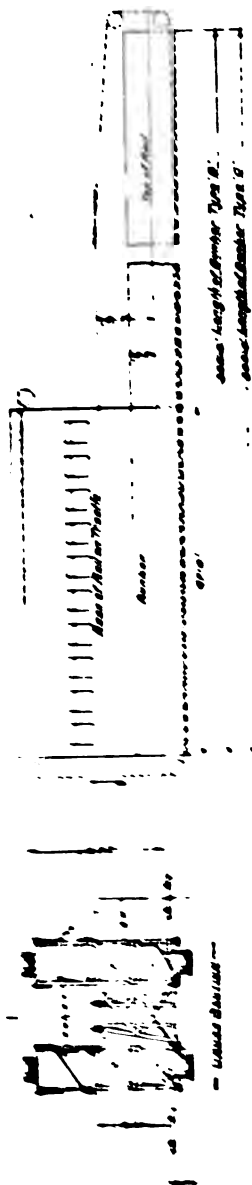
a period of six months, including both stored and directly-handled coal, and also information from the Boston & Albany Company to the effect that coal has been handled from the storage pile to the coal-chute pocket for a longer period of time at a rate of two and seven-tenths cents per ton.

PLAN NO. 7. This illustrates the link-belt conveyor plant as operated on the Southern Pacific road, in which coal is delivered from an elevated trestle into storage on either side of the same, and two link-belt conveyors handle this stored coal, delivering it to coal-chute pockets, from which it goes directly to the tenders. This is one of the types plans of which were sent in response to circular No. 25 above referred to. No details are given as to the cost of handling coal by this method.

PLAN NO. 8. This plan illustrates an approved plan in use and under construction on the Great Northern road, referred to in the response to circular No. 25 and reproduced on a small scale from the large detailed plans sent in reply to that circular. This provides for the delivery of coal at the foot of a steep incline, leading to a track within the coal chute up which incline cars are hauled by steel cable, winding on a drum or hoisting machine, operated by gasoline engine. The coal is dumped or shoveled from these cars into storage bins having a capacity of approximately two hundred tons. These bins deliver the coal into ordinary coal-chute pockets, which are generally arranged ten on each side of the center track, and from these pockets the coal is delivered direct to engines. It is claimed that one man will operate a plant of this kind unless a very large amount of coal is to be handled, when two men only will be required, and it is expected that coal will be handled at the rate of three and one-half cents per ton or less. It must be acknowledged, however, that a plant of this character would not handle coal economically in small quantities, as the interest on the first cost and the cost of maintenance, if distributed amongst a small tonnage, would increase the rate per ton two or three-fold above the price named.

PLAN NO. 9. The ninth plan gives a sketch of a link-belt conveyor plant in use by the Illinois Central Railroad Company at Twenty-Sixth Street, Chicago. This plan is briefly described as follows: Coal is delivered in either one of two track hoppers adjacent to the building. Preferably dumping cars should be used; ordinarily, however, a large proportion of the coal is shoveled from the cars. From the track hoppers, the coal is delivered to a conveyor by an automatic device, and carried up by a regular elevator belt with buckets attached to the top of the tower at one end of the coal-chute building. This elevator delivers the coal to a conveyor which runs the whole length of the building in the cupola above the level of the chutes, descends at one end of the building, and passes through a small tunnel in the floor, ascending again at the other end. Tributary to the upper run of the conveyor are traps and spouts by means of which the coal is delivered into the ordinary coal chutes, of which there are twenty on each side of the building. From these it is delivered direct to the tenders. Surplus coal not required for delivery to the coal chutes is delivered into store, the whole bottom of the building beneath the coal chutes being constructed for storage. The bottom of the bin is nearly level. The coal is taken from store at the end of the pile wherever it may be in the building by lifting movable planking which covers the tunnel in the floor through which the conveyor travels. This coal is redelivered to the elevator, which, in turn, delivers it again to the upper section of the conveyor, from which it passes to the chutes.

This plan has been in operation for approximately three years and accurate data have been kept as to the cost of its operation. As shown by the plans, it handles cinders and sand as well as coal. A summary of the cost of its operation for eighteen months is as follows:



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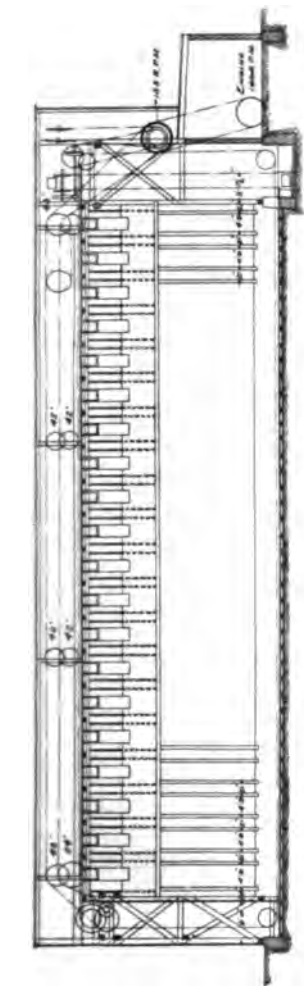
SOUTHERN PACIFIC RAILWAY CO  
COALING STATIONS TYPES B AND C  
PLAN No 7 — Scale 1/4" = 1' 0"



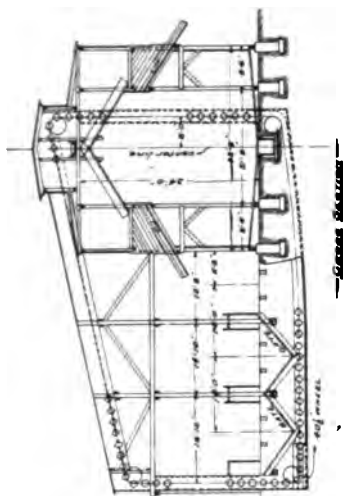
Locustville, Station

Locustville, Station  
Double Coal Chute  
Plan No 8 — Scale 1/4" = 1' 0"

Top of Span 1  
88' 0"

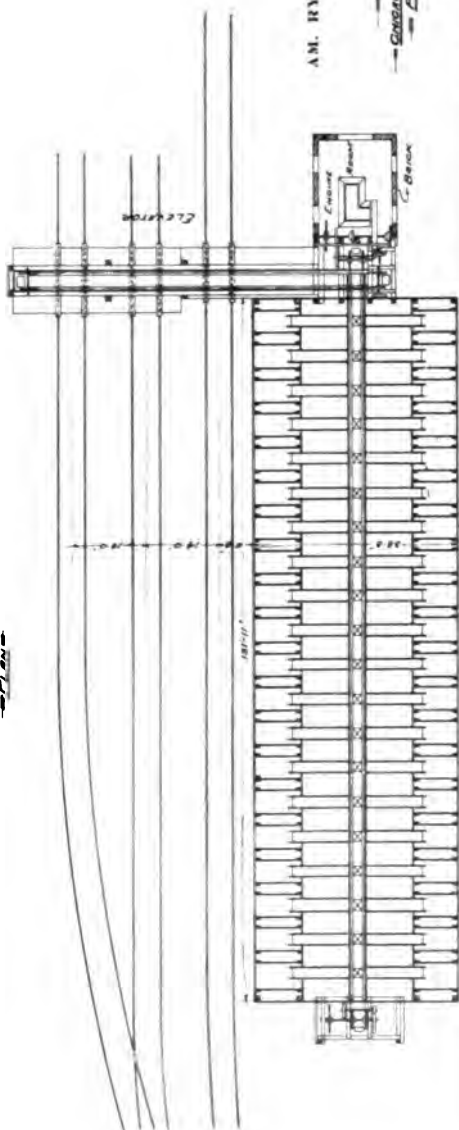


—Longitudinal Section—



—Cross Section—

—Plan—



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—CODE STORAGE AND GALLERY—  
—CONCRETE TRUSS ROOF FOR THE GALLERY—  
—CLAY TILE— —SLOPE 1/2 IN. 12 IN.

Total tons of coal handled, 164,623.

Wages of coal men unloading coal.....	\$10,129.11 or 6.15c per ton
Repairs of machinery.....	1,452.76 or .88c per ton
Wages of man operating steam engine.....	900.00 or .55c per ton

Total cost .....	\$12,481.87 or 7.58c per ton
------------------	------------------------------

The cost of handling coal should be considered also with reference to the other work done by this plant, and this involves a statement of the cost of handling cinders and sand. The following is a summary of this cost:

Cinders received from 56,240 engines.

Wages of laborers .....	\$1,811.17 or 3.22c per engine
Repairs of machinery .....	750.86 or 1.33c per engine

Total cost .....	\$2,562.03 or 4.55c per engine
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Cost of handling sand:

Wages of laborers .....	\$1,416.12 or 2.52c per engine
Repairs of machinery .....	116.03 or .20c per engine

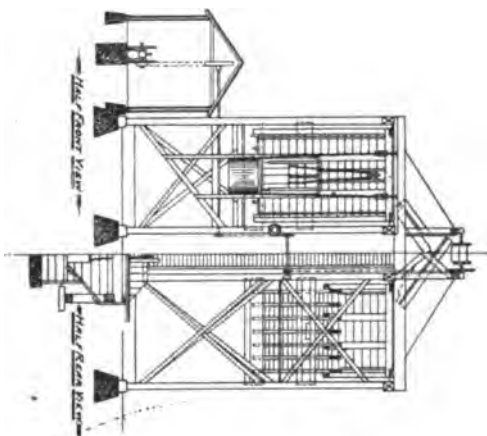
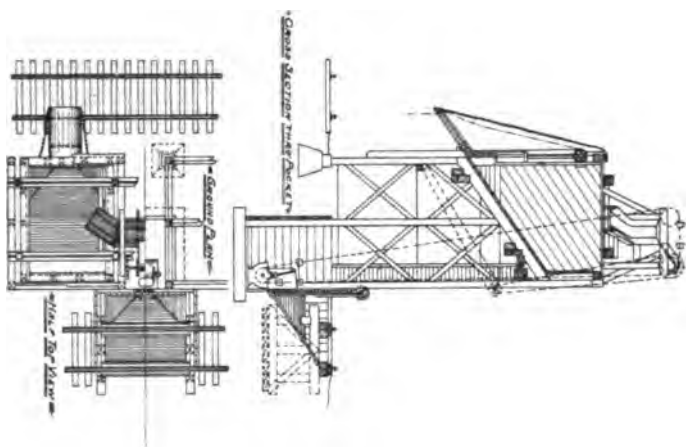
Total cost .....	\$1,532.15 or 2.72c per engine
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PLAN NO. 10. The tenth plan shows a type of coaling plant as constructed by Fairbanks, Morse & Co., which is advocated as serviceable in case of small stations, but as to which no satisfactory data giving cost of operation are available. This is the general type which is referred to in the response to the circular from the Northern Pacific Company, and which is stated to operate at a cost of seven cents per ton.

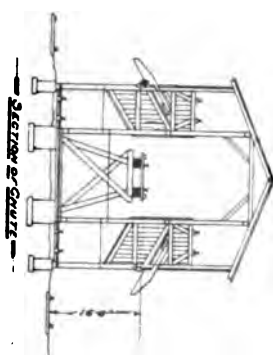
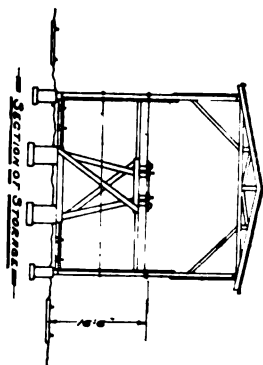
Your Committee is unable from the data which it has now obtained to make any decided recommendations in regard to the adoption of coaling plants. The data at hand are too meager, the descriptions of plants used are too vague, and the data as to cost of operation are insufficient to permit any sound opinion to be formed at present.

The following general conclusions may perhaps be safely stated:

In proportion to the amount of coal to be handled yearly, railroad companies will be justified in the construction of more and more expensive coaling plants. The simpler types are inexpensive in first cost and in maintenance, but more expensive in operation; that is, in the cost of labor, and it would be feasible that, with accurate information as to cost of original construction, cost of operation and cost of maintenance, one could calculate with reasonable accuracy at what yearly rate of coal handled it would be economical to build mechanical plants; but the improvements which are being made from year to year in the details of construction and methods of operation of mechanical plants and the lack of sufficient data as to the items of cost above named make it impossible to give anything more than a general suggestion as to the point where the simpler should give place to the more complex mechanism. At present it seems probable that where a coaling station handles a yearly amount of fifty thousand tons, a well-designed mechanical plant should operate economically, and



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CHICAGO, ILL.



this would be especially true if it should be desired to store any large proportion of the total amount of coal to be handled. The question of storage as already alluded to is a very vital one, and the importance of providing storage for coal is evident from the following considerations:

First—It is unsafe to depend entirely upon the daily delivery of coal in coal cars for engine use. The uncertainties of transportation, the danger of strikes at coal mines, and of strikes, riots and other disturbances to transportation, make it almost absolutely essential that some storage should be provided for. This in many cases is accomplished by having a surplus of coal in transit, or held in cars at or near the coaling station and at large terminals, where it may be readily available for the company's use, in case of emergency.

Second—The expense of storage of this kind, namely, in cars either at coaling points or at terminals, foots up to an enormous figure, if we consider the average valuation, or equivalent daily rental of each coal car. The approximate cost of this service on the Illinois Central Railroad System is estimated at upwards of one-half million dollars per year.

Third—The coal cars in ordinary service are most in demand for commercial business during the fall and winter months, and it is desirable to store coal at points remote from the mines during the summer months when this equipment is not in such great demand, and when the output of the mines can be transported and stored without competition from commercial business. Where coal is stored in open piles, either on the ground or upon rough platforms, it is expensive to unload this coal at the outset, and still more expensive to reload the same and to deliver it to the coal chutes (or directly to tenders) as may be desired. This expense can be enormously reduced by the use of a proper mechanical plant.

Fourth—The deterioration of coal stored in open piles without protection is a very important consideration. Depending upon the climate and the amount of exposure, it is estimated that in a few months' time coal will lose from 10 to 25 per cent. of its value as fuel. This is partly caused by slacking or crumbling to pieces and partly by slow chemical change which goes on in the coal itself. The storage of coal in closed bins is frequently objected to on account of the risk from fire. It is believed, however, that, by taking the precaution to put only dry coal into store, and by designing the storage bins in such way that any portion of the contents may be drawn upon at will, also by providing means for determining whether the coal is heating, these objections may be overcome.

Your Committee desires to call the attention of the members of the Association to the coöperation which each should furnish by the contribution of accurate data on this subject. They have in preparation, and will present in the near future, a circular containing a set of interrogations, which it is hoped, through the influence of members of the Association, will receive due consideration, and will furnish data which may be made available for the use of those members who wish to derive some immediate benefit from the investigations which are in progress by the several committees. It is perhaps not worth while at present to outline to any greater extent the scope of the inquiries which will be covered by this circular, further than to emphasize the importance of giving accurate description of some particular plant, with accurate data as to the cost of its construction, its operation and its maintenance. This would include also information as to the

total number of tons handled at the station, the amount stored and the cost of the various steps in the process of unloading, storing and handling the coal.

### RAILROAD WATER TANKS.

It was the intention of the Committee on Buildings to report on the subject of Water Tanks at the annual convention last year. In response to a general request for plans made by the Secretary of the Association, only two plans of tanks were received. In February, 1901, special requests for water-tank plans were sent to a large number of railroads, but plans were not received in time to permit the subject to be presented at the convention in March, 1901.

Following is the result of requests for water-tank plans:

Requests sent to 100 railroads, representing 169,976 miles,  
Plans received from 45 railroads, representing 93,896 miles,  
Or 55 per cent..  
Photographs received from 3 railroads, representing 2,926 miles,  
Of answers received stating they had no standard plans, 17 railroads,  
representing 24,994 miles,  
Or 15 per cent.  
No response from 35 railroads, representing 48,160 miles, or 28 per cent.

From plans received, a tabulated statement, giving dimensions of nearly every part of structure, has been prepared and forms part of this report. No attempt will be made in this report to review the especially good features, nor to criticise the bad ones of each design, nor will the Committee at this time submit a standard plan to the Association or make any recommendations. All that it attempts to accomplish is to show, in detail, by means of the tabulated statements, the actual construction now in use, and then in the following synopsis state what appears to be the general practice and to point out departures from such practice as may be worthy of the consideration of the Association.

**STYLE OF TANK IN GENERAL USE.**—The almost universal style of tanks now in use, as shown by the plans, is a wooden tub 24 feet in diameter and 16 feet high, supported by 12 wooden posts. In all the following, a structure, with tub of this dimension, is to be understood unless otherwise noted. Most of the plans show tank located near the track and arranged to deliver water to engines by ordinary spouts, only three or four roads specifying that tank shall be placed at most convenient location and water delivered through water column.

**FOUNDATIONS.**—Three plans show pile foundations; one cedar posts set upon cross-blocking about 6 feet below surface; two circular stone walls extending up to bottom of tub; six stone cross-walls upon which sills or posts rest; 25 stone pedestals under each post; three concrete pedestals; two specify either stone or concrete pedestals; one stone or brick pedestal, and one does not specify foundations.

Of the 16 plans specifying depth of foundation, 15 placed it at from 3 feet 6 inches to 8 feet. The Great Northern Railway has radically de-

parted from the usual aim of placing bottom of foundation below the frost line, and specifies one stone 3 feet 6 inches plan by 1 foot thick, under each post.

**TANK FRAME.—I—Posts:** The usual construction is 12 posts of 12 inch by 12 inch timber. Plans showing other construction are as follows:—

- (a) Circular stone walls carrying tub:  
 Delaware & Hudson Co., for wooden tub 14 feet in diameter and 14 feet high.  
 Mexican Central Ry., for metal tub 21 feet in diameter and 14 feet high.
- (b) Metal posts:  
 Cincinnati, Hamilton & Dayton Ry., 12 posts of old rails.  
 Minneapolis & St. Louis R. R., 12 posts of 4 old track rails each.  
 Oregon Short Line R. R., 10 posts of hollow cast 10 inches in diameter.  
 Pittsburg & Lake Erie R. R., 12 posts of 8 inch 12lb. I-beams.  
 Union Pac. R. R., 10 posts of hollow cast iron 10 inches in diameter.
- (c) Wooden frame other than 12 posts, 12"x12" in size:  
 Burlington's Missouri Lines, 21 posts 12"x12" for tub 26 feet in diameter.  
 Burlington's Missouri Lines, 30 posts 12"x12" for tub 30 feet in diameter.  
 Chicago & No. Western Ry., 16 posts 14"x14".  
 Chi., St. Paul, Minn. & Omaha Ry., 16 posts 12"x12".  
 Fre., Elk. & Mo. Val. R. R., 16 posts 14"x14".  
 Michigan Central R. R., 16 posts 12"x12" for tub 30 feet in diameter.  
 New York, New Haven & Hartford R. R., 21 posts 10"x10".  
 Nashville, Chattanooga & St. Louis Ry., 4 posts 10"x10".  
 (8 posts 10" in dia.) for tub 20 feet in diameter.  
 Philadelphia & Reading Ry., 16 posts 12"x12".  
 Rio Grande Western Ry., 14 posts 12"x12".  
 Wabash R. R., 21 posts 12"x12".

All the plans show all posts vertical except for the C. & N. W. Ry. and F. E. & M. V. R. R. There are various styles of bracing used, which are illustrated in the attached plates.

2.—Sills: Nine plans show sills used beneath posts.

3.—Caps: Caps vary in size from 10"x12" to 12"x16", but in most cases are 12"x12". Two plans specify old rails for caps. Sixteen plans show cast iron blocks used between tops of posts and caps.

4.—Joists: Great variation occurs in the size, number and arrangement of joists. Eleven plans show a single set of joists. The C. R. I. & P. Railway uses 18 old rails; the Northern Pacific Railway 22 old rails; and the Great Northern Railway 16 I-beams 6"x12¼". The other eight plans show wooden joists varying in number from 12 to 21 and in size from 4"x10" to 6"x16". Twenty-two plans show a double set of joists, varying greatly in size and number. One plan shows 34 main joists 4"x12", and the same number of "clime" joists 3"x4". Four plans show "clime" joists laid in same direction and on top of main joists.

TUB.—The tub in common use is 24 feet in diameter and 16 feet high. Four roads, as follows, specify larger tubs:

- Burlington Missouri Lines, tub 26' in diameter by 16' high; also tub 30' in diameter by 18' high.
- Cincinnati, New Orleans & Texas Pacific Ry., tub 25' in diameter by 16' high.
- Michigan Central R. R., tub 30' in diameter by 16' high.
- Chicago & Alton Ry. uses a 90,000 gallon wooden tub on steel frame.

The Mexican Central Railway's is a standard metal tub, 20 feet in diameter, resting upon circular masonry walls. The Texas & Pacific Railway uses a tub of corrugated galvanized steel, supported upon wooden frame. The Chief Engineer of this road states that he finds it more satisfactory than a wooden tub in the arid and semi-arid regions traversed by the Texas & Pacific Railway and seemingly just as satisfactory upon any portion of the line. He says the cost is about the same as for a wooden tub. More than half of the plans show neither kind or dimension of material in tub. Seventeen plans show staves 3" thick and from 5" to 8" wide and bottom boards 3" thick and from 6" to 12" wide. Two roads, the Chicago & North Western Railway and Fremont, Elkhorn & Mo. Valley Railroad, specify thicknesses of 4" for both staves and bottom. The difference in diameter between top and bottom of tub varies from 6" to 14". As to finish at bottom of tub, fourteen plans show a wooden table construction extending out from tub, and sixteen plans show a wooden band a little less in diameter than bottom of tub and covering ends of joists or else a jacket of wooden construction or galvanized iron extending below caps.

Twenty plans give number, width and thickness of hoops. The number used for tub 24' in diameter and 16' high varies from 10 to 14. Four plans show all hoops 5" wide by 3-16" thick; one plan all 4" wide by  $\frac{1}{4}$ " thick, and one plan all 4" wide by 3-16" thick; the remaining 13 plans vary both the width and thickness of hoops, using wide, thick hoops at bottom and thinner, narrower hoops toward the top of tub. One road uses riveted drive hoops for tub 20' in diameter, the others, so far as shown, use some style of screw clamps.

Roof.—The plans give quite a variety of roof designs. The accompanying plates of small scale drawings show about half of the plans obtained. Twenty-four plans show rafters 2"x6"; six plans 2"x4"; one plan 2"x12" for flat roof; and six roads use no rafters. The roof for six plans having no rafters is constructed of two courses of radial boards supported by two built-up wooden circles cut from 2"x8" material, and a conical block at crown. The lower circle rests upon top of tub, and is fastened to it by eye bolts; the other circle is located about midway between top of tub and crown, and is carried by short studs, supported by joists, which in turn rest upon the lower circles. The conical block rests upon a center post. Two plans specify tar felt, and one building paper to be placed between the courses of radial boards and the whole covered with shingles; only one specifies shingles only, and one uses

two courses of tar felt between the two courses of boards, but no shingles. The roof construction, as shown on the plans where rafters are used, is summarized as follows: Plans showing roof of boards and battens, 3; floorings, 2; two courses matched lumber with tar paper between, 1; radial board sheeting and shingles, 4; common sheeting and shingles, 4; common sheeting and shingles, 8; flooring and shingles, 1; H-G lumber, tar paper and shingles, 4; sheeting and slate, 1; common sheeting and tin, 1; H-G lumber and tin, 2; matched boarding, covered with three-ply felt, 1; sheeting tar paper, with tar and gravel roof, 1.

**FROST PROOFING.**—The construction, by necessity, varies with location of road. Some roads in the South show no frost-proof chamber. A few of the Northern roads house in the entire tank frame and provide for stove with pipe passing up through tub; but on the majority of roads a chamber is constructed through which to carry the pipes from the surface to the bottom of the tub. This chamber is usually square, with length of side as shown on plans varying from 1' 10" to 9' 0". The construction is usually of wooden walls, varying in number from 1 to 6, with air space between walls. On most of the plans each of the walls is of H-G lumber, with one layer of building paper. One road uses two brick walls, with a space of 2' 4" between, filled with fine cinders, another 6" space filled with charcoal dust between wooden walls, and another uses sawdust for filling alternate spaces.

A few plans show ceiling below the joists or between the two sets of joists, and about half the plans show ceiling or flooring above tub.

**FIXTURES.**—Most of the plans are lacking in data on fixtures. But four plans show tank connected with water column. Two plans give supply pipe 5" in diameter, three plans 4" in diameter, and two plans 3" in diameter. Three plans specify that supply pipe shall extend to top of tank, while eight plans make it end at the bottom; one plan, 18" above bottom, and one plan shows it connected to discharge pipe leading to water column. The discharge pipe varies from 6½" to 12" in diameter. The height above top of rail of track end of goose-neck varies from 10' 3½" to 14' 9". Nine plans show overflow pipes varying in size from 2" to 6".

The foregoing matter covers all that it is thought necessary to say in comparing the several plans presented by the accompanying drawings. The drawings themselves have been prepared rather as typical of what has actually been done, than as suggestive of what may be finally decided as most desirable. Knowing, however, that all engineers are interested in the records of existing work, the Committee present the information in this shape, deeming that it will be of sufficient interest to warrant publication.

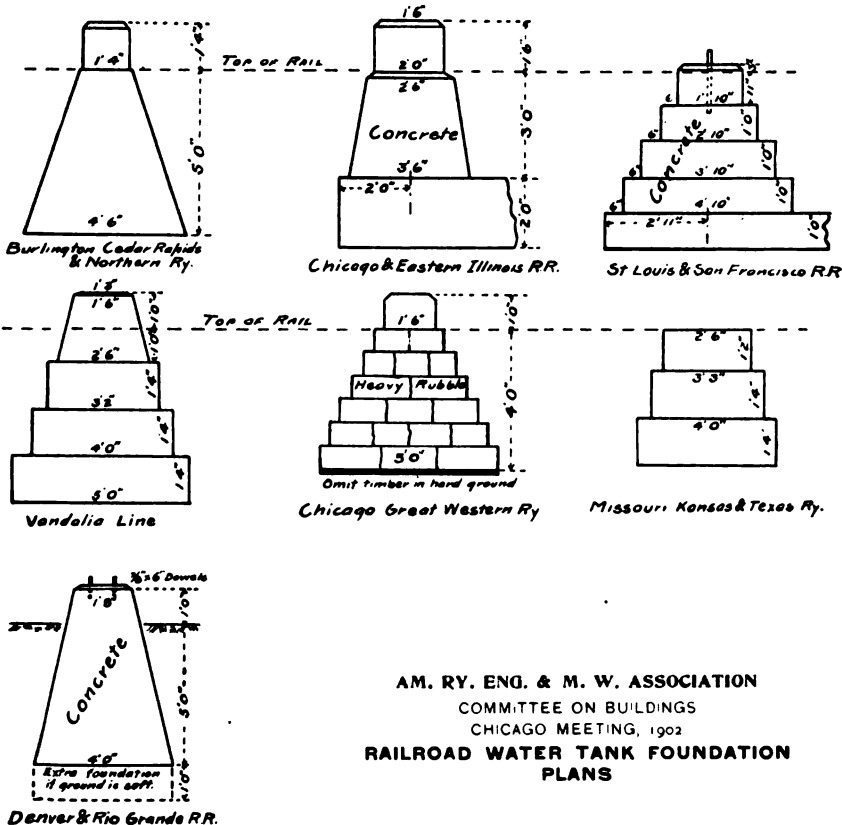
Amongst the plans presented, none are given of iron or steel tanks, a form of construction which is now coming into use, and which may supersede eventually the construction of wooden tanks. Tanks of this kind are in use in several places by railroad companies which are represented

among the membership of this Association, and the Committee hope that this branch of the subject may be discussed as supplemental to this preliminary report.

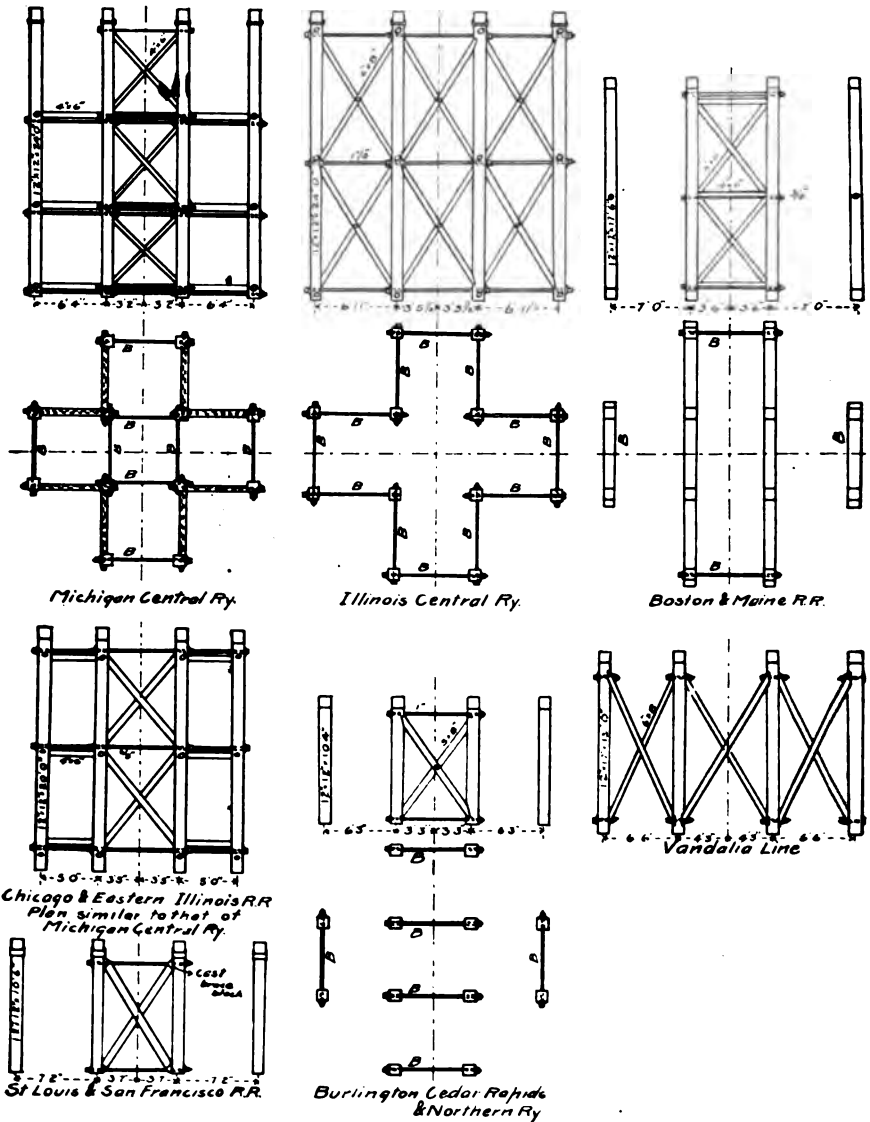
Respectfully submitted,

H. W. PARKHURST, Illinois Central Railroad, Chicago, *Chairman*;  
 A. R. RAYMER, Pittsburg & Lake Erie Railroad, Pittsburg, *Vice-Chairman*;  
 A. S. MARKLEY, Chicago & Eastern Illinois Railroad, Danville, Ill.;  
 C. T. NORTON, Mexican Int. Railroad, Porfirio Diaz, Mex.;  
 B. C. GOWEN, Wisconsin & Michigan Railroad, Peshtigo, Wis.;  
 E. C. MACY, Chicago Great Western Ry., St. Paul, Minn.;  
 H. W. COWAN, Colorado & Southern Railroad, Denver, Colo.;

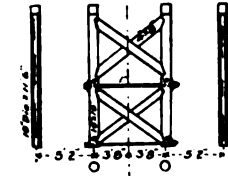
*Committee.*



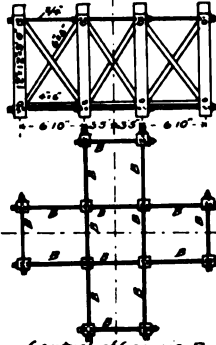
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 COMMITTEE ON BUILDINGS  
 CHICAGO MEETING, 1902  
**RAILROAD WATER TANK FOUNDATION  
 PLANS**



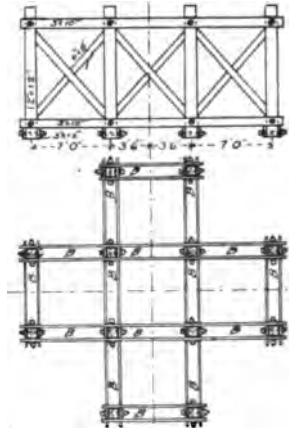
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 CHICAGO MEETING, 1902  
 RAILROAD WATER TANK FRAMES



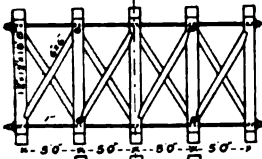
*Nashville, Chattanooga  
& St. Louis Ry.*



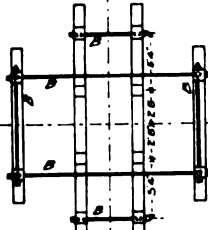
*Central of Georgia Ry.  
S.A.L. Ry. Similar  
C.N. & T.P. Ry.*



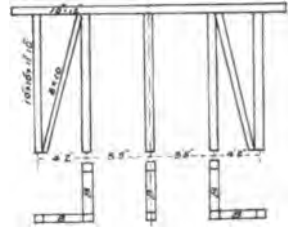
*Louisville & Nashville Ry.*



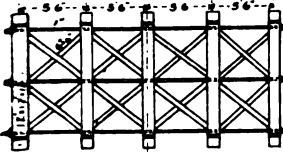
*Wabash R.R.*



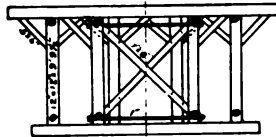
*Colorado & Southern Ry.  
M.K. & T. Ry. similar  
but has no sills*



*New York, New Haven  
& Hartford R.R.*

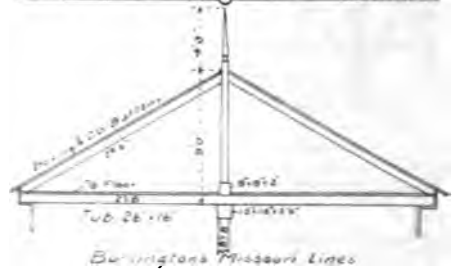
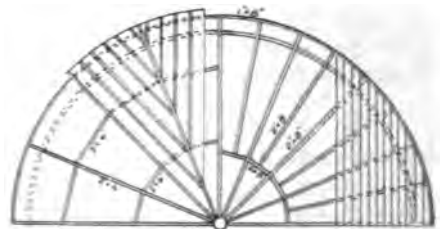
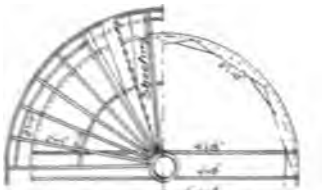
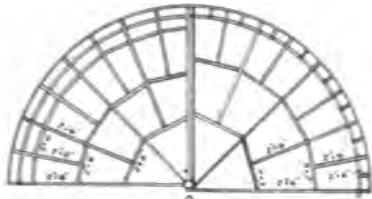
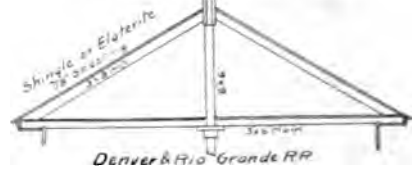
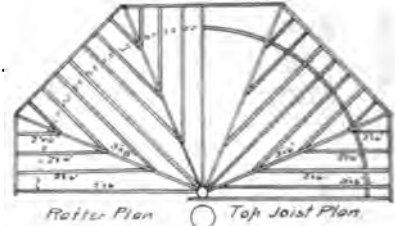
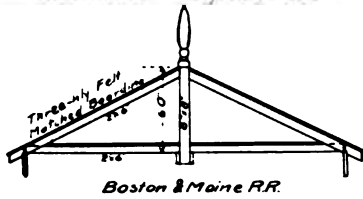
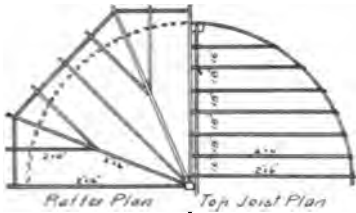


*Burlington's Missouri Lines  
Plan similar to that of  
Wabash R.R.*

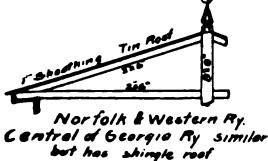
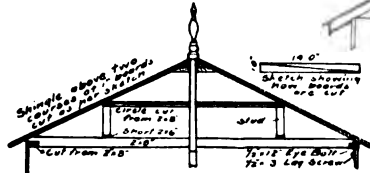
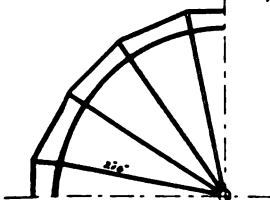
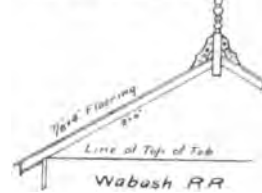
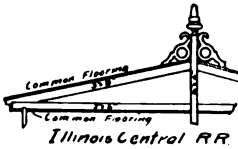
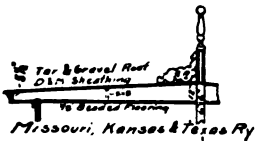
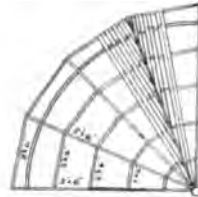
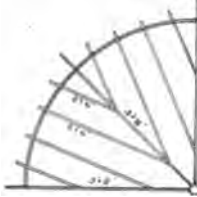
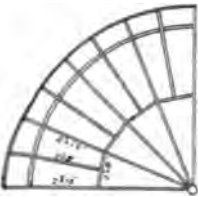
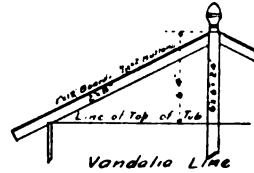
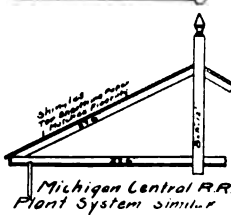
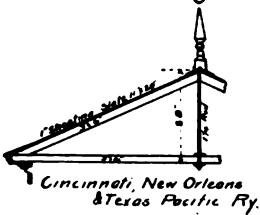
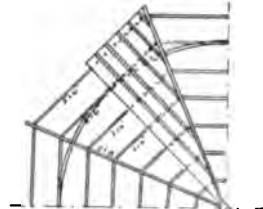
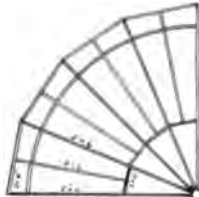
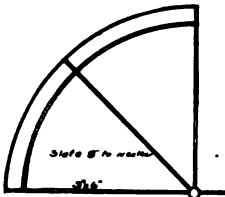


*Colorado & Southern Ry.  
Elevation parallel to track*

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RAILROAD WATER TANK FRAMES



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RAILROAD WATER TANK ROOF PLANS  
SCALE  $\frac{1}{2}$  = 1 FOOT



Minneapolis, St Paul & South Ste Marie Ry.  
The following named  
roads use similar roof  
Chicago Great Western Ry.  
Great Northern Ry.  
Kansas City Southern Ry.  
Northern Pacific Ry.  
Seaboard Air Line Ry.

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COMMITTEE ON BUILDINGS

CHICAGO MEETING, 1902

## RAILROAD WATER TANK ROOF PLANS

SCALE 1" = 1 FOOT

Name of Railroad	Size of Tub		Tub										Finish at bottom of tub.
	Diameter in.	Height	Marked Capacity Gals.	Kind of Wood Specified	Staves		Bottom		Exact inside Diameter at Bottom	Exact inside Diameter at Top			
					Thickness in.	Width in.	Thickness in.	Width in.					
Ann Arbor R. R.	20	14	---	---	---	---	---	---	---	---	---	Water table	
Boston & Maine R. R.	24	16 1/2	---	---	---	---	---	---	---	---	---	" "	
B. C. R. & N. Ry.	22	16	No	plan	of	tub	---	---	---	---	---	1" wooden band to bottom of joint	
Burlington's Mo. Lines	26	16	---	---	---	---	---	---	---	---	---	" " " " " "	
" " "	30	18	---	---	---	---	---	---	---	---	---	" " " " " "	
Canadian Pacific Ry.	24	16	40000	---	3	5	3	9	---	---	---	Frame housed in.	
Central of Georgia Ry.	24	16	50000	---	---	---	---	---	---	---	---	1" wooden band to bottom of joint	
Chesapeake & Ohio Ry.	24	16	50000	---	---	---	---	---	---	---	---	Water table.	
C. G. W. Ry.	24	16	---	---	---	---	---	---	---	---	---	1" wooden band to bottom of joint	
C. M. & St. P. Ry.	24	16	---	---	---	---	3	---	23' 11"	23' 3"	---	---	
C. & N. W. Ry.	24	16	---	---	4	6	4	10	23' 10 1/2"	---	---	Wooden jacket	
C. R. I. & P. Ry.	24	16	---	Soft Pine	3	---	3	---	24' 00"	23' 4"	---	Galvanized iron jacket 24" wide	
C. St. P. M. & O. Ry.	24	16	---	---	3	5	3	10	---	---	---	Frame housed in.	
C. & E. I. R. R.	24	16	---	---	---	---	---	---	---	---	---	Water table	
C. O. & G. R. R.	24	16	---	---	---	---	---	---	---	23' 00"	---	" "	
C. H. & D. Ry.	24	16	---	---	---	---	---	---	24' 00"	23' 00"	---	" "	
C. N. O. & T. P. Ry.	25	16	52000	---	3	5	3	12	---	---	---	Water table.	
Colorado & Southern	24	16	55400	---	---	---	---	---	---	---	---	---	
Delaware & Hudson	21	14	30553	---	---	---	---	---	21' 00"	20' 02"	---	Wooden bund.	
Denver & Rio Grande	24	16	---	---	---	---	---	---	---	---	---	No. 20 galvanize iron jacket 24" wide	
D. S. S. & A. Ry.	24	16	---	---	3	---	---	---	---	---	---	Frame housed in	
F. E. & M. V. Ry.	24	16	Plan	same	as	C. & N. W. Ry.	---	---	---	---	---	---	
Great Northern Ry.	24	16	---	---	3 1/4	6 1/2	3 1/4	12	---	---	---	---	
Illinois Central R. R.	24	16	52000	---	3	6	3	12	---	---	---	Water-table	
Kansas City Southern	24	16	---	White Pine	3	8-10	3	---	24' 00"	23' 00"	---	Wooden band to bottom of joint	
Louisville & Nashville	24	16	---	---	2 1/2	6	3	---	---	---	---	None, ends of caps & joints exposed	
Mexican Central Ry.	20	14	3300	Metal tank	on	masonry	---	---	---	---	---	---	
Michigan Central R. R.	24	16	---	---	---	---	---	---	---	---	---	Water-table.	
" " "	30	16	---	---	---	---	---	---	---	---	---	" "	
M. & St. L. Ry.	24	16	---	---	---	---	---	---	---	---	---	Frost jacket around tank extend below ground	
M. St. P. & S. Ste. M.	24	16	---	Soft Pine	3	---	3	---	---	---	---	1" wooden band to bottom of joint	
M. K. & T. Ry.	24	16	---	---	---	---	---	---	---	---	---	None, ends of caps & joints exposed	
N. Y. C. & H. R. R. R.	24	16	50000	---	---	---	---	---	---	---	---	Water table.	
N. Y. N. H. & H. R. R.	24	16 1/2	52000	---	---	---	---	---	---	---	---	---	
N. C. & St. L. Ry.	20	16	---	Red Cedar	3	6	3	8	---	---	---	Wooden jacket to bottom of caps	
Norfolk & Western Ry.	24	16	50000	White Pine	3	---	3	---	---	23' 00"	---	Water table.	
Northern Pacific Ry.	24	16	48000	---	2 3/4	8	2 1/4	12	23' 10 1/2"	23' 2 1/2"	---	---	
Oregon Short Line	24	16	Plan	same	as	Union Pacific R.	---	---	---	---	---	---	
P. & R. Ry.	24	16	50000	---	---	---	---	---	---	---	---	Wooden band to bottom of joint	
Plant System	24	16	50000	---	3	---	3	---	---	---	---	Water table	
R. G. W. Ry.	24	16	---	---	2 1/2	3	2 1/2	10	24' 00"	23' 00"	---	Wooden jacket	
S. A. L. R. R.	24	16	---	---	---	---	---	---	---	---	---	Wooden band to bottom of joint	
St. L. & S. F. R. R.	24	16	---	---	---	---	---	---	---	---	---	Water table	
Union Pacific R. R.	24	16	---	Red Wood	3	6	3	10	---	---	---	Wooden jacket	
Vananda Line	24	16	49840	White Pine	3	6	3	6	24' 00"	22' 10"	---	Water-table	
Wabash R. R.	24	16	48500	White Pine	3	---	3	---	---	23' 00"	---	None	

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Name of Railroad	Water Tank Fixtures												
	Supply Pipe		Discharge Pipe					Over-flow Diameter	Shout				
	Diameter	Location of point of discharge into tub	Diameter	Height of Center of Gravity Above Footing	Distance of End of Discharge from Center of Gravity of Footing	Where connected with tub.	Diameter small end		Diameter large end	Length of tees, elbows, etc., in line	How supported	Kind of Weight Guides	
Ann Arbor R. R.	---	At bottom	10"	10' 4"	7' 3"	Center	---	---	16"	8' 3"	Hinge Chain	Loose Pipe	
Boston & Maine R. R.	---	---	---	---	8' 3"	---	---	---	---	---	---	---	
B. C. R. & N. Ry.	---	---	---	---	---	---	---	---	---	---	---	---	
Burlington's Mo. Lines	---	---	---	---	---	---	---	---	---	---	---	---	
Canadian Pacific Ry.	---	---	10"	13' 6"	7' 11 1/2"	Center	2"	11 1/2"	16 1/2"	8' 8"	Chain	1" Rod	
Central of Georgia Ry.	---	---	---	---	8' 6"	Side	---	---	---	---	---	---	
Chesapeake & Ohio Ry.	---	At top	9"	---	---	---	---	11"	15"	8' 4 1/2"	---	1/2"	
C. G. W. Ry.	---	At bottom	---	---	8' 3"	---	---	---	---	---	---	---	
C. M. & St. P. Ry.	---	---	7"	---	10' 0"	---	---	3"	15 1/2"	10' 4"	---	Pipe	
C. & N. W. Ry.	---	At bottom	10"	14' 3"	---	Side	4"	---	13 1/2"	11' 1"	---	Box	
C. R. I. & P. Ry.	---	---	7"	---	8' 2"	8' 8"	---	---	---	---	---	Rod	
C. St. P. M. & O. Ry.	4"	6' from bottom into discharge as standard pipe	---	13' 0"	---	Center	4"	---	---	---	---	Loose	
C. & E. I. R. R.	---	---	12"	12' 2 1/2"	---	---	---	Manistfield	---	---	Column	---	
C. O. & G. R. R.	---	---	---	---	---	---	---	---	---	---	Chain	---	
C. H. & D. Ry.	---	---	8"	---	---	---	4"	---	---	---	---	Loose	
C. N. O. & T. P. Ry.	---	---	---	---	---	---	---	---	---	---	---	---	
Colorado & Southern	---	---	8"	---	---	---	---	8"	12"	9' 0"	Chain	Rod	
Delaware & Hudson	---	---	---	10' 3 1/2"	6' 3 1/2"	---	---	5"	8"	6' 7"	Hinge	---	
Denver & Rio Grande	---	---	10"	---	---	---	---	11"	21"	11' 1"	Chain	Box	
D. S. S. & A. Ry.	---	---	---	14' 0"	10' 0"	---	---	---	18"	12' 0"	---	1" Pipe	
F. E. & M. V. Ry.	---	Same as C. & N. W. Ry.	as	12' 6"	---	9' 3"	Center	---	12"	13"	10' 0"	Chain	Rod
Great Northern Ry.	4"	18' from bottom	6 1/2"	---	---	---	Side	---	10"	17"	---	Chain	Rod
Illinois Central R. R.	---	---	7"	11' 10"	---	Center	4"	---	8"	20"	9' 2"	Hinge	Loose
Kansas City Southern	---	---	---	---	---	---	---	---	---	---	---	---	---
Louisville & Nashville	---	---	---	---	---	---	---	---	---	---	---	---	---
Mexican Central Ry.	---	---	---	---	---	---	---	---	---	---	---	---	---
Michigan Central R. R.	---	---	---	---	---	---	---	---	---	---	---	---	---
M. & St. L. Ry.	---	---	10"	---	---	Side	---	---	---	---	---	---	---
M. St. P. & S. Ste. M.	3"	---	7"	---	8' 3"	Center	2"	---	---	---	Chain	Rod	
M. K. & T. Ry.	---	---	---	---	7' 2 1/2"	---	---	---	---	---	---	---	Loose
N. Y. C. & H. R. R. R.	---	---	---	---	---	---	---	---	---	---	---	---	---
N. Y. N. H. & H. R. R.	---	---	---	---	---	---	---	---	---	---	---	---	---
N. C. & St. L. Ry.	---	---	8"	---	---	---	---	---	---	---	---	---	---
Norfolk & Western Ry.	---	---	10"	12' 4"	7' 8 1/2"	8' 3 1/2"	Center	★	14"	8' 6 1/2"	Hinge Chain	Loose	
Northern Pacific Ry.	3"	At bottom	10"	12' 10"	8' 0"	Center	2"	---	---	---	Chain	Loose	
Oregon Short Line	---	Same as Union Pacific R. R.	as	---	---	---	---	---	---	---	---	---	---
P. & R. Ry.	4"	At top	8"	---	---	---	Side	---	6"	---	---	Chain	Rod
Plant System	---	---	10"	---	---	---	---	---	---	---	---	---	---
R. G. W. Ry.	---	At top	7"	---	---	---	---	10"	---	8' 0"	---	Box	Rod
S. A. L. R. R.	---	---	---	---	---	8' 5"	Side	---	---	---	---	---	---
St. L. & S. F. R. R.	---	---	---	---	---	---	---	10"	13"	10' 8"	---	---	---
Union Pacific R. R.	5"	At bottom	10"	---	8' 3 1/2"	9' 0"	6' 6" from Center	5"	11"	15"	10' 0"	1-Letter Hinge	Box
Vandalia Line	---	---	---	---	---	---	---	---	---	---	---	---	Loose
Wabash R. R.	---	---	8"	13' 3"	9' 3"	Side	---	---	---	---	Chain	---	---

★ oval-Size 10" x 14"

Name of Railroad	Roof											Roof Proper.	Size of Top Joists	Ceiling or Floor above Tub
	Rise above Top of Tub	Shape	Center Post			Size of Rafters	Sheeting	Size of Joists	Size of Ceiling or Floor above Tub					
			Spanning	Shape	Spanning									
	Feet	Feet	Feet	Feet	Feet	Feet	Feet	Feet	Feet	Feet	Feet	Feet	Feet	Feet
Am Arbor R. R.	---	R	6x6	---	---	2x4	Radial Boards	Shingle	---	---	---	---	---	---
Arden & Maine R. R.	6'0"	R	---	8'0"x12"	---	2x6	Matched Boarding	3 ply Felt	2x6	None	---	---	---	---
C. R. & N. Ry.	---	---	No plan of roof	---	---	---	---	---	---	---	---	---	---	---
Burlington's Mo. Lines	9'0"	R	8x8	---	4'3"	2x6	None	Boards & OG Bat	2x8	1/2 Flooring	---	---	---	---
" " " "	9'0"	R	8x8	---	4'3"	2x6	"	"	2x8	6 & T Flooring.	---	---	---	---
Canadian Pacific Ry.	4'0"	R	16	1/2 in center	---	2x6	1 1/2" T & G Boards	Canada Plote	---	2 courses of No. 1 Boards	---	---	---	---
Central of Georgia Ry.	5'3"	R	8x8	---	---	2x6	Shingle	Shingle	2x6	None	---	---	---	---
Delaware & Chic Ry.	---	R	---	8'0"x10"	---	2x6	1' OG T Sheeting	Ter Paper	2x8	None	---	---	---	---
G. W. Ry.	---	R	---	---	---	---	1' Radial Board	Shingles	---	None	---	---	---	---
M. & St. P. Ry	5'4"	R	6x6	---	---	2x6	Building Paper	Shingles	---	2 courses of No. 1 Boards	---	---	---	---
N. W. Ry	6'0"	R	6x6	---	---	2x4	1' Radial Boards	Shingles	---	2 courses of No. 1 Boards	---	---	---	---
P. I. & P. Ry	6'6"	R	16	x	4'6"	2x6	1' Common Boards	Cedar Shingles	---	None	---	---	---	---
St. P. M. & O. Ry	3'0"	R	6x6	---	---	2x6	Matched Flooring	Star-A Shingles	2x8	2 courses of No. 1 Boards	---	---	---	---
E. I. R. R.	---	---	---	6x6	---	2x6	1' Radial Boards	Shingles	2x4	2 courses of No. 1 Boards	---	---	---	---
O. & G. R. R.	5'0"	R	x	x	5'0"	2x6	None	1 1/2" Sheeting & 1/2" Battens	---	None	---	---	---	---
H. & D. Ry.	6'10"	R	8x8	---	---	2x4	1/2 Boards	Shingles	---	1/2 Boards	---	---	---	---
N. O. & T. P. Ry	5'8"	R	---	11'6" rad	---	2x6	1" Boards	Slate 8 to w.	3x6	None	---	---	---	---
Orlando & Southern Ry.	4'0"	R	---	6'6"x6"	4'0"	2x6	None	1" Radial & Battens	2x8	Sheathing	---	---	---	---
Quebec & Hudson Bay	4'5"	R	---	---	---	---	---	---	---	---	---	---	---	---
Rio Grande	---	R	6x6	---	---	2x6	1 1/2" Rough for 1/2" Finishing for 1/2" Battens & Ter Paper	Shingles or Slate	2x8	1/2 Matched	---	---	---	---
S. S. & A. Ry.	---	R	---	6'6"x12"	---	2x4	---	Shingles	2x4	2 courses of No. 1 Boards	---	---	---	---
E. & M. V. Ry.	---	---	Same as C. & N. W. Ry.	---	---	---	---	---	---	---	---	---	---	---
East Northern Ry.	---	R	---	---	---	---	2 courses of Radial B. Ter Felt between	Shingles	---	None	---	---	---	---
East Central R. R.	---	R	6x6	---	---	---	None	None	2x6	Flooring	---	---	---	---
Great City Southern	---	R	---	10'6"x14"	---	None	None	2x Radial Boards, 2x Ter Felt & 6"x12" w.	---	None	---	---	---	---
Greene & Nashville	---	R	---	6'6"x12"	---	2x6	1/2 Sheathing	Cypress Shingles	3x8	1/2 T & G	---	---	---	---
Indian Central Ry.	---	---	No roof	---	---	---	---	---	---	---	---	---	---	---
Sugar Central R. R.	---	---	16	8'0"x12"	---	2x6	1" Matched Flooring & Ter Paper	Shingles.	2x6	---	---	---	---	---
" " " "	---	---	16	8'6"x14"	---	2x6	Do	Do	2x6	---	---	---	---	---
& St. L. Ry.	---	R	---	---	---	---	---	---	---	---	---	---	---	---
St. P. & S. Ste. M.	5'6"	R	---	---	---	None	2x 1" Radial B.	Shingle	2x8	None	---	---	---	---
K. & T. Ry.	1'0"	R	6x6	---	---	2x12	Sheathing & Ter P.	Ter & Gravel	---	1 1/2 Sheathing, 1c 1" Boards, 2" battens	---	---	---	---
Y. C. & H. R. R. R.	---	R	---	---	---	2x6	---	Ter P. & Shingles	---	---	---	---	---	---
Y. N. H. & H. R. R. C.	---	---	No plan of roof	---	---	---	---	---	---	---	---	---	---	---
C. & St. L. Ry.	---	R	Cast Center	---	---	2x4	3/4 Matched	Tin	4x8	1/2 Ceiling	---	---	---	---
Rock & Western Ry	4'0"	R	8x8	---	2'0"	2x6	1" Boards	Tin	2x6	---	---	---	---	---
Western Pacific Ry	---	R	---	---	---	None	2x 1" Radial B. & Ter Paper	Shingle	---	2 courses of No. 1 Boards	---	---	---	---
Union Short Line	---	---	Same as Union Pacific R.	---	---	---	---	---	---	---	---	---	---	---
& R. Ry.	---	R	8'0" rad	---	---	---	None	2x 1" Matched Flooring & Ter Paper & Battens	---	---	---	---	---	---
Ut. System	---	R	---	---	---	2x6	---	---	2x6	---	---	---	---	---
G. W. Ry.	---	R	6x6	---	---	2x6	1" Rough Boards	Shingle	---	1/2 Flooring	---	---	---	---
A. L. R. R.	---	R	---	---	---	None	1" Plank	Shingle	2x6	None	---	---	---	---
L. & S. F. R. R.	---	R	---	---	---	2x6	Radial	Ready Rock	2x6	---	---	---	---	---
San Pacific R. R.	---	R	6x6	---	3'0"	2x4	1" OG T Flooring & Ter Paper	Shingle	---	2 courses of No. 1 Boards	---	---	---	---
Delta Line	6'4"	R	---	6'6"x16"	---	2x8	---	1 1/2 Battens & OG Battens	---	None	---	---	---	---
Kash. R. R.	---	R	---	---	4'2"	2x6	None	1/2 Flooring	None	None	---	---	---	---

Name of Railroad	Size of Tub		Miles of Road Operated	Description of Plan				Foundation						
	Diameter ft.	Height ft.		Kind of Plan	Date	Scale (1"=)		Kind of Foundation	Size of Cob-stone	Size of Base	Top above Top of Rail	Top below Top of Rail	Depth from Top of Rail	
						Gen'l Plan	Details							
Ann Arbor R. R.	20	14	292	Standard Plan	---	1/2		12 Piles						42
Boston & Maine R. R.	24	16 1/2	2263	"	1892	1/4		Stone	24"x24"x15"					15
B. C. R. & N. Ry.	22	16	1305	"	1900	1/2		"	16"x16"x16"	54"x54"	16"			64
Burlington's Mo. Lines	26	16	1135	Plan	1899	1/4		Stone	24"x24"x15"	34"x34"	0			50
"	30	18		"	1893	1/4		"	24"x24"x15"	34"x34"	0			
Canadian Pacific Ry.	24	16	8200	Standard Plan				Stone						
Central of Georgia Ry.	24	16	1834	"	1900	3/8					10"			
Chesapeake & Ohio Ry.	24	16	1477	"	1892	1/4	3/4	"	18"x18"x12"		0			
C. G. W. Ry.	24	16	1168	"	---	1/8	1/4	"	18"x18"x12"	5"x5"	12"			50
C. M. & St. P. Ry.	24	16	6596	"				"	18"x18"	5"x5"				80
C. & N. W. Ry.	24	16	5562	"				"	24"x24"					50
C. R. I. & P. Ry.	24	16	4131	"				"	24"x24"					
C. St. P. M. & O. Ry.	24	16	1557	Plan	1895	1/2		"	18"x18"		11"			
C. & E. I. R. R.	24	16	727	Standard Plan	1901	1/4		Concrete	18"x18"x18"	40"x40"	18"			60
C. O. & G. R. R.	24	16	650	"				Stone	24"x24"	4"x4"				53
C. H. & D. Ry.	24	16	621	Typical Plan				Stone	24"x24"	4"x4"				40
C. N. O. & T. P. Ry.	25	16	336	Standard Plan	1896	1/4		Concrete or Stone	30"x30"x15"	5"x5"	0			
Colorado & Southern	24	16	1142	"	1900	1/2		20 Piles			0			
Delaware & Hudson	21	14	747	"				Tub	on Stone	Walls				
Denver & Rio Grande	24	16	1675	Plan	1900	1/2	1 1/2	Concrete	24"x24"	4"x4"				60
D. S. S. & A. Ry.	24	16	579	"	1892	3/8		24 Piles						
F. E. & M. V. Ry.	24	16	1332	Same as	C & N. W.			Ry.						
Great Northern Ry.	24	16	4969	Standard Plan				Stone	42"x42"x12"	42"x42"				18
Illinois Central R. R.	24	16	4265	"	1895	1/2		"	20"x20"		0			
Kansas City Southern	24	16	831	"	1895	1/4		"	18"x18"x12"	5"x5"	10"			
Louisville & Nashville	24	16	3297	"	1896	3/8		"	24"x24"x12"	54"x54"				5
Mexican Central Ry.	20	14	2135	"	1896	1/4	3/4	Tub	on Stone	Walls				
Michigan Central R.R.	24	16	1662	Plan	1896	1/2		"						
"	30	16		"	1896	1/2		"						
M. & St. L. Ry.	24	16	642	Standard Plan				Stone or Concrete	20"x20"x16"	56"x56"				
M. St. P. & S. Ste. M.	24	16	1310	Plan	1898	3/8	3/4	Cedar Posts			12"			60
M. K. & T. Ry.	24	16	2389	Standard Plan	1890	1/2		Stone	30"x30"	4"x4"	0			34
N. Y. C. & H. R. R. R.	24	16	2881	"				"	18"x18"x12"	5"x5"				
N. Y. N. H. & H. R. R.	24	16 1/2	2038	"	---	1/4		"	24"x24"x18"					
N. C. & St. L. Ry.	20	16	1196	"	1901	1/2		"	24"x24"					
Norfolk & Western Ry.	24	16	1570	"	1899	3/8		"	18"x18"	40"x40"				
Northern Pacific Ry.	24	16	4989	"				Concrete	18"x18"	4"x4"				54
Oregon Short Line	24	16	1683	Same as	Union		Pacific	Ry.						
P. & R. Ry.	24	16	1453	Plan	1897	1/4		Stone			0			
Plant System	24	16	2183	Standard Plan	1896	1/2		Stone			0			
R. G. W. Ry.	24	16	671	"	1897	1/2		Stone						64
S. A. L. R. R.	24	16	2595	"	1897	1/2		Stone			10"			40
St. L. & S. F. R. R.	24	16	1905	"	1898	1/2		"	22"x22"		5			
Union Pacific R. R.	24	16	3631	"				"	24"x24"x15"	64"x64"				64
Vandalia Line	24	16	412	"	1895	3/8		"	15"x15"	5"x5"	12"			
Wabash R. R.	24	16	2275	"	1891	1/4		Stone			5			

Name of Railroad	General Dimensions						Frost-proofing				
	Distance Center of the Frost-proofing from the Center of the Frost-proofing	Distance from East Post from Center of Frost-proofing	Height Below Top of Rail	Diameter of Tub	Height of Tub	Size Outside of Chamber	General Dimensions			Walls	
							Size Inside of Chamber	Number		Number	Width Air Space
Ann Arbor R. R.	---	10' 5"	11' 8"	20'	14'	---	---	3		2	---
Boston & Maine R. R.	21' 0"	10' 0"	22' 0"	24'	16' 6"	80"x150"	70"x140"	2	1 wall boards, 1 wall boards & paper	1	4"
B. C. R. & N. Ry.	20' 4"	10' 4"	14' 0"	22'	---	50"x50"	22"x22"	6	Each 1" flooring & bldg paper.	5	2"
Burlington's Mo. Lines	24' 6"	13' 0"	13' 0"	26'	16'	66"x66"	16"x16"	4	Not given	*	---
"	---	---	23' 0"	30'	18'	84"x68"	16"x16"	4	"	*	---
Canadian Pacific Ry.	21' 5"	10' 5"	13' 6"	24'	16'	---	---	---	Frame housed in.	---	---
Central of Georgia Ry.	20' 2"	10' 11"	12' 3"	24'	16'	---	---	---	---	---	---
Chesapeake & Ohio Ry.	21' 3"	9' 6"	12' 6"	24'	16'	80"x80"	64"x64"	2	Each 1" 6" 6" 8" 8" for paper	1	6"
C. G. W. Ry.	21' 3"	11' 0"	12' 3"	24'	16'	50"x50"	---	---	---	---	---
C. M. & St. P. Ry.	23' 2"	12' 5"	13' 6"	24'	16'	57"x57"	27"x27"	4	Each 1" T. & G.	3	3"
C. & N. W. Ry.	23' 0"	---	19' 9"	24'	16'	54"x44"	30"x20"	4	Each 1" 6" 6" bldg paper	3	2"
C. R. I. & P. Ry.	21' 5"	10' 8"	13' 6"	24'	16'	610"x610"	54"x54"	3	Each 1" 6" 6" bldg paper.	1	2"
C. St. P. M. & O. Ry.	22' 6"	---	13' 11"	24'	16'	---	---	---	Frame housed in.	---	---
C. & E. I. R. R.	---	---	24' 4"	24'	16'	78"x78"	64"x64"	2	2 courses boards & tar paper	1	---
C. O. & G. R. R.	21' 3"	10' 0"	13' 4"	24'	16'	610"x610"	---	---	---	---	---
C. H. & D. Ry.	21' 4"	10' 0"	12' 0"	24'	16'	81"x81"	59"x59"	2	Each 2" 1/2 D.B.T. for felt between	---	1
C. N. O. & T. P. Ry.	24' 11"	10' 0"	12' 0"	25'	16'	---	---	---	Each 1" T. & G. & tar paper	1	12"
Colorado & Southern	21' 0"	10' 0"	13' 0"	24'	16'	---	---	---	---	---	---
Delaware & Hudson	18' 6"	---	11' 6"	21'	14'	---	---	---	Tub on stone wall.	---	---
Denver & Rio Grande	22' 0"	12' 0"	---	24'	16'	80"x70"	50"x48"	3	Each 2" 1/2 flooring & tar paper	2	4"
D. S. S. & A. Ry.	---	---	15' 4"	24'	16'	82"x82"	510"x510"	2	Each 1" flooring & tar paper	1	12"
F. E. & M. V. Ry.	23' 0"	---	19' 3"	24'	16'	Same	as C. N. W.	---	Frame housed in.	---	---
Great Northern Ry.	22' 3"	11' 3"	16' 0"	24'	16'	---	20"x30"	4	1" 1/2 to 1 3/4 boards & 1/2 to 3/4 boards. All have 1/2" tar paper	3	2"
Illinois Central R. R.	20' 6"	9' 8"	16' 3"	24'	16'	---	---	---	---	---	---
Kansas City Southern	21' 3"	11' 0"	12' 6"	24'	16'	---	26"x36"	4	Each 1/2" 1/2" fencing & tar paper	3	2"
Louisville & Nashville	21' 6"	10' 6"	13' 0"	24'	16'	---	---	---	---	---	---
Mexican Central R. R.	19' 0"	9' 0"	14' 0"	20'	14'	---	---	---	Tub on stone wall.	---	---
"	---	---	26' 6"	24'	16'	110"x110"	12"x12"	2	Each 1" matched flooring	1	2"
"	---	---	26' 6"	30'	16'	110"x110"	12"x12"	2	Each 1" matched flooring	1	2"
M. & St. L. Ry.	21' 10"	10' 8"	14' 0"	24'	16'	84"x84"	16"x14"	2	1/2 brick & 1/4 brick wall	*	---
M. St. P. & S. St. M.	27' 3"	---	13' 6"	24'	16'	64"x64"	36"x36"	6	Each 2" 1/2 D.B.T.	3	1"
M. K. & T. Ry.	21' 0"	12' 6"	13' 0"	24'	16'	60"x60"	40"x40"	3	---	2	---
N.Y.C. & H. R. R. R.	---	---	23' 0"	24'	16'	710"x710"	62"x62"	2	1" boards	1	8"
N.Y.N.H. & H. R. R.	---	---	---	24'	---	---	---	---	---	---	---
N. C. & St. L. Ry.	21' 0"	11' 3"	13' 7"	20'	16'	88"x88"	86"x86"	1	1" boards & battens	0	---
Norfolk & Western Ry.	21' 11"	11' 5"	13' 6"	24'	16'	78"x78"	66"x66"	2	1/2 flooring	1	---
Norfolk Pacific Ry.	22' 0"	11' 0"	15' 0"	24'	16'	90"x90"	60"x60"	4	Each 2" 1/2 6" 8" tar paper	2	2"
Oregon Short Line	22' 0"	12' 7"	18' 0"	24'	16'	Same	as	---	Union Pacific R.R.	---	---
P. & E. Ry.	---	---	20' 0"	24'	16'	34"x32"	70"x510"	2	1" 1/2 G. yellow pine	1	12"
Pilot System	21' 5"	10' 5"	15' 4"	24'	16'	---	---	---	---	---	---
R. G. W. Ry.	21' 6"	11' 3"	12' 0"	24'	16'	518"x518"	42"x42"	2	Each 2" 1" boards	**	---
S. A. L. R. R.	21' 5"	10' 5"	11' 6"	24'	16'	---	---	---	---	---	---
St. L. & S. F. R. R.	24' 0"	12' 3"	13' 5"	24'	16'	---	---	---	---	---	---
Union Pacific R. R.	22' 0"	12' 7"	18' 0"	24'	16'	44"x44"	20"x20"	4	Each 2" D.B.T. flooring & tar paper	---	---
Vandalia Line	23' 10"	12' 7"	18' 6"	24'	16'	---	---	---	---	---	---
Wabash R. R.	22' 6"	12' 0"	14' 0"	24'	16'	---	---	---	---	---	---

\* Burlington's Lines in Missouri - 1 air space & 2 spaces filled with sawdust.  
 \*\* M. & St. L. Ry. - 1 space, 2" wide, filled with fine cinders  
 \*\*\* R. G. W. Ry. - 1 space 6" wide, filled with charcoal dust.

Name of Railroad	Size Tub	Hoops—width, thickness and spacing commencing at bottom of reb. Dimensions in inches.															
		1st	2nd	3rd	4th	5th	6th	7th	8th	9th	10th	11th	12th	13th	14th	15th	16th
		Width	Thickness	Width	Thickness	Width	Thickness	Width	Thickness	Width	Thickness	Width	Thickness	Width	Thickness	Width	Thickness
Ann Arbor R. R.	20 14																
Boston & Maine R. R.	24 16																
B. C. R. & N. Ry.	22 16																
Burlington's M. L. Ry.	26 16																
Canadian Pacific Ry.	30 18	6 1/4	3/16	6 1/2	3/16	6 1/2	3/16	6 1/2	3/16	6 1/2	3/16	6 1/2	3/16	6 1/2	3/16	6 1/2	3/16
Central Georgia Ry.	24 16	6 1/4	3/16	6 1/2	3/16	6 1/2	3/16	6 1/2	3/16	6 1/2	3/16	6 1/2	3/16	6 1/2	3/16	6 1/2	3/16
Chicago & Erie Ry.	24 16	6 1/4	3/16	6 1/2	3/16	6 1/2	3/16	6 1/2	3/16	6 1/2	3/16	6 1/2	3/16	6 1/2	3/16	6 1/2	3/16
C. G. W. Ry.	24 16	6 1/4	3/16	6 1/2	3/16	6 1/2	3/16	6 1/2	3/16	6 1/2	3/16	6 1/2	3/16	6 1/2	3/16	6 1/2	3/16
C. M. & St. P. Ry.	24 16	6 1/4	3/16	6 1/2	3/16	6 1/2	3/16	6 1/2	3/16	6 1/2	3/16	6 1/2	3/16	6 1/2	3/16	6 1/2	3/16
C. & N. W. Ry.	24 16	6 1/4	3/16	6 1/2	3/16	6 1/2	3/16	6 1/2	3/16	6 1/2	3/16	6 1/2	3/16	6 1/2	3/16	6 1/2	3/16
C. R. I. & P. Ry.	24 16	6 1/4	3/16	6 1/2	3/16	6 1/2	3/16	6 1/2	3/16	6 1/2	3/16	6 1/2	3/16	6 1/2	3/16	6 1/2	3/16
C. S. P. M. & O. Ry.	24 16	6 1/4	3/16	6 1/2	3/16	6 1/2	3/16	6 1/2	3/16	6 1/2	3/16	6 1/2	3/16	6 1/2	3/16	6 1/2	3/16
C. & E. I. R. R.	24 16	6 1/4	3/16	6 1/2	3/16	6 1/2	3/16	6 1/2	3/16	6 1/2	3/16	6 1/2	3/16	6 1/2	3/16	6 1/2	3/16
C. O. & G. R. R.	24 16	6 1/4	3/16	6 1/2	3/16	6 1/2	3/16	6 1/2	3/16	6 1/2	3/16	6 1/2	3/16	6 1/2	3/16	6 1/2	3/16
C. H. & D. Ry.	24 16	6 1/4	3/16	6 1/2	3/16	6 1/2	3/16	6 1/2	3/16	6 1/2	3/16	6 1/2	3/16	6 1/2	3/16	6 1/2	3/16
C. N. O. & T. P. Ry.	25 16	6 1/4	3/16	6 1/2	3/16	6 1/2	3/16	6 1/2	3/16	6 1/2	3/16	6 1/2	3/16	6 1/2	3/16	6 1/2	3/16
Colorado & Southern	24 16	6 1/4	3/16	6 1/2	3/16	6 1/2	3/16	6 1/2	3/16	6 1/2	3/16	6 1/2	3/16	6 1/2	3/16	6 1/2	3/16
Delaware & Hudson	21 14	6 1/4	3/16	6 1/2	3/16	6 1/2	3/16	6 1/2	3/16	6 1/2	3/16	6 1/2	3/16	6 1/2	3/16	6 1/2	3/16
D. & W. & Rio Grand	24 16	6 1/4	3/16	6 1/2	3/16	6 1/2	3/16	6 1/2	3/16	6 1/2	3/16	6 1/2	3/16	6 1/2	3/16	6 1/2	3/16
D. S. & A. Ry.	24 16	6 1/4	3/16	6 1/2	3/16	6 1/2	3/16	6 1/2	3/16	6 1/2	3/16	6 1/2	3/16	6 1/2	3/16	6 1/2	3/16
F. E. & M. V. Ry.	24 16	6 1/4	3/16	6 1/2	3/16	6 1/2	3/16	6 1/2	3/16	6 1/2	3/16	6 1/2	3/16	6 1/2	3/16	6 1/2	3/16
Great Northern Ry.	24 16	6 1/4	3/16	6 1/2	3/16	6 1/2	3/16	6 1/2	3/16	6 1/2	3/16	6 1/2	3/16	6 1/2	3/16	6 1/2	3/16
Illinois Central R. R.	24 16	6 1/4	3/16	6 1/2	3/16	6 1/2	3/16	6 1/2	3/16	6 1/2	3/16	6 1/2	3/16	6 1/2	3/16	6 1/2	3/16
Kansas City Southern	24 16	6 1/4	3/16	6 1/2	3/16	6 1/2	3/16	6 1/2	3/16	6 1/2	3/16	6 1/2	3/16	6 1/2	3/16	6 1/2	3/16
Louisville & Nashville	24 16	6 1/4	3/16	6 1/2	3/16	6 1/2	3/16	6 1/2	3/16	6 1/2	3/16	6 1/2	3/16	6 1/2	3/16	6 1/2	3/16
Mexican Central Ry.	20 14	6 1/4	3/16	6 1/2	3/16	6 1/2	3/16	6 1/2	3/16	6 1/2	3/16	6 1/2	3/16	6 1/2	3/16	6 1/2	3/16
Michigan Central R. R.	24 16	6 1/4	3/16	6 1/2	3/16	6 1/2	3/16	6 1/2	3/16	6 1/2	3/16	6 1/2	3/16	6 1/2	3/16	6 1/2	3/16
M. & St. L. Ry.	24 16	6 1/4	3/16	6 1/2	3/16	6 1/2	3/16	6 1/2	3/16	6 1/2	3/16	6 1/2	3/16	6 1/2	3/16	6 1/2	3/16
M. St. P. & S. Ste. M.	24 16	6 1/4	3/16	6 1/2	3/16	6 1/2	3/16	6 1/2	3/16	6 1/2	3/16	6 1/2	3/16	6 1/2	3/16	6 1/2	3/16
M. K. & T. Ry.	24 16	6 1/4	3/16	6 1/2	3/16	6 1/2	3/16	6 1/2	3/16	6 1/2	3/16	6 1/2	3/16	6 1/2	3/16	6 1/2	3/16
N. Y. C. & H. R. R.	24 16	6 1/4	3/16	6 1/2	3/16	6 1/2	3/16	6 1/2	3/16	6 1/2	3/16	6 1/2	3/16	6 1/2	3/16	6 1/2	3/16
N. Y. N. H. & H. R. R.	24 16	6 1/4	3/16	6 1/2	3/16	6 1/2	3/16	6 1/2	3/16	6 1/2	3/16	6 1/2	3/16	6 1/2	3/16	6 1/2	3/16
N. C. & St. L. Ry.	20 16	6 1/4	3/16	6 1/2	3/16	6 1/2	3/16	6 1/2	3/16	6 1/2	3/16	6 1/2	3/16	6 1/2	3/16	6 1/2	3/16
Norfolk & Western Ry.	24 16	6 1/4	3/16	6 1/2	3/16	6 1/2	3/16	6 1/2	3/16	6 1/2	3/16	6 1/2	3/16	6 1/2	3/16	6 1/2	3/16
Norfolk Pacific Ry.	24 16	6 1/4	3/16	6 1/2	3/16	6 1/2	3/16	6 1/2	3/16	6 1/2	3/16	6 1/2	3/16	6 1/2	3/16	6 1/2	3/16
Oregon Short Line	24 16	6 1/4	3/16	6 1/2	3/16	6 1/2	3/16	6 1/2	3/16	6 1/2	3/16	6 1/2	3/16	6 1/2	3/16	6 1/2	3/16
P. & R. Ry.	24 16	6 1/4	3/16	6 1/2	3/16	6 1/2	3/16	6 1/2	3/16	6 1/2	3/16	6 1/2	3/16	6 1/2	3/16	6 1/2	3/16
Plant System	24 16	6 1/4	3/16	6 1/2	3/16	6 1/2	3/16	6 1/2	3/16	6 1/2	3/16	6 1/2	3/16	6 1/2	3/16	6 1/2	3/16
R. G. W. Ry.	24 16	6 1/4	3/16	6 1/2	3/16	6 1/2	3/16	6 1/2	3/16	6 1/2	3/16	6 1/2	3/16	6 1/2	3/16	6 1/2	3/16
S. A. L. R. R.	24 16	6 1/4	3/16	6 1/2	3/16	6 1/2	3/16	6 1/2	3/16	6 1/2	3/16	6 1/2	3/16	6 1/2	3/16	6 1/2	3/16
St. L. & S. F. R. R.	24 16	6 1/4	3/16	6 1/2	3/16	6 1/2	3/16	6 1/2	3/16	6 1/2	3/16	6 1/2	3/16	6 1/2	3/16	6 1/2	3/16
Union Pacific	24 16	6 1/4	3/16	6 1/2	3/16	6 1/2	3/16	6 1/2	3/16	6 1/2	3/16	6 1/2	3/16	6 1/2	3/16	6 1/2	3/16
Van Hook & N. Ry.	24 16	6 1/4	3/16	6 1/2	3/16	6 1/2	3/16	6 1/2	3/16	6 1/2	3/16	6 1/2	3/16	6 1/2	3/16	6 1/2	3/16
Western N. Ry.	24 16	6 1/4	3/16	6 1/2	3/16	6 1/2	3/16	6 1/2	3/16	6 1/2	3/16	6 1/2	3/16	6 1/2	3/16	6 1/2	3/16

Mr. H. W. Parkhurst (Illinois Central):—Mr. President and Gentlemen of the Association: After a conference, the Committee has concluded that it would probably be better to read a small portion of the report, covering the conclusions to which we have come, so that they may be brought before you for consideration.

(Chairman Parkhurst here quoted from the report, see page 160.)

Perhaps it is not necessary to read any more of these. I think this will introduce the subject sufficiently for consideration.

President Kittredge:—The Committee on Buildings have devoted themselves to the consideration mainly of coaling stations and water stations, and we will consider that the subject of coaling stations is open now for discussion.

Mr. J. H. Abbott (Baltimore & Ohio):—We have on the Baltimore & Ohio, Cleveland Division, two coaling stations which are very satisfactory. We had one put up about two years ago and in the past year another. The amount of coal used at each station is about 30,000 tons a year, somewhere from 100 to 120 tons a day. The cost to us has been a little less than  $2\frac{1}{2}$  cents per ton, and we think our methods are vastly superior to the old methods of the coal trestles. We have the Fairbanks & Morse system.

President Kittredge:—I would like to ask Mr. Abbott if the  $2\frac{1}{2}$  cents a ton includes the interest on the original investment and the cost of the maintenance of the plant?

Mr. Abbott:—Yes, sir. It does.

President Kittredge:—Your coal is handled from hopper-bottom cars or shovel cars?

Mr. Abbott:—From hopper-bottom cars or side cars, and it is put directly into the pocket.

Mr. H. C. Phillips (Santa Fe):—I would like to ask on how small a daily consumption of coal you get  $2\frac{1}{2}$  cents a ton—that is, how small a station, whether in a station using 50 or 60 tons a day coal can be handled at that rate?

Mr. Abbott:—This is my only experience with coaling stations. Our use varies a little over 80 tons to about 100 to 120, and the one station is smaller, handling about 80 tons. It is just about the same cost per ton in each. For 50 or 60 tons a day, I could not answer.

Mr. F. H. McGuigan (Grand Trunk) :—I would like to ask the gentleman the cost of installing the plant.

Mr. Abbott :—I do not believe I can answer that right off. I have forgotten the figure of the cost. In round numbers, last year, we put into the Canal-Dover plant, as I recollect it, about \$5,000—the entire expense—but I may be a little off. We have a gasoline engine at the Canal-Dover plant. At Lorain we use an electric engine.

President Kittredge :—At the Lorain plant do you generate your own power, or do you get your current from some other source?

Mr. Abbott :—We have it in connection with the shop; not for this specific purpose alone.

Mr. E. E. Hart (New York, Chicago & St. Louis) :—We have a plant built of old bridge material at one station, costing \$7,500, and at Fort Wayne the plant was built entirely of new timber and cost us about \$8,500, with a 100-ton chute; capacity of 50 tons an hour.

President Kittredge :—I would like to ask Mr. Hart what he means by a 50-ton chute? Is it a single pocket, holding 50 tons?

Mr. Hart :—No. The capacity of the plant is 50 tons an hour, elevating into the chutes; two pockets of 50 tons each, making 100 tons for the plant; that is, we can store in the pockets 100 tons of coal, but it will elevate 50 tons per hour.

Prof. C. F. Allen (Massachusetts Institute of Technology) :—There is one point that I have failed to notice in the report, although it may be there. In the case of the plants where the coal is lifted by bucket or conveyor and the incline is dispensed with, a very considerable value results from the saving of room in the yard, which is very commonly too small anyway. Even where the cost might sometimes possibly be materially greater, the total advantage to the yard, to the whole plant, would oftentimes be very much increased by the release of that room for general yard purposes, and that oftentimes would be of extraordinary value, when just that extra room would make the yard reasonably good.

Mr. Parkhurst :—Permit me to refer Mr. Allen to the report, topic No. 1, in which that item is referred to: "The location may determine largely the nature of the plant to be used. Where large quantities of fuel are to be handled with only a limited

amount of room for the construction of tracks and buildings, an expensive mechanical plant may be fully justified. At other points, where land values are small, a totally different style of plant may be most economical."

Prof. Allen:—I am very glad to know that it is there, and regret that I failed to take note of it.

Mr. W. B. Poland (Baltimore & Ohio Southwestern):—During the last year, on the division on which I am located, we have put up two coaling devices, which are practically the same capacity and seem to be rather interesting for comparison. One is a link-belt machine of a storage capacity of 500 tons, and of lifting capacity of about 60 tons an hour. It has four chutes and is operated by a dynamo. The power is obtained from a shop plant, so there is no power expended except when the machine is in operation. The cost of the plant was about \$12,000—within a few hundred dollars of that. The other plant is one of slightly less storage capacity. I think there are 10 chutes on a side. It is of the incline type, in which the coal is dumped on top of the trestle. The coal is handled in both cases in side or bottom dump cars. The capacity per hour of the incline plant is probably a little greater than the elevator plant. Recently the master mechanic and myself made some rough comparisons of the cost. They were based on the expense of about three months' labor at the two plants. They included the interest on the investment, and what we estimated would be the cost of renewal, and the annual repairs, and we determined as closely as we could from such calculation that the expense at both plants was practically the same, and as nearly as we could figure, with only a few months to go on, about 2.7 cents per ton.

M. Hart:—I would like to inquire about the difficulties in operating these plants, and would also like to state what difficulties we have found. The link-belt elevator chutes necessitate, in most localities, a very deep pit. In one of our plants we are troubled with water. If there is a sudden change of temperature it is apt to freeze up on us unless watched closely. In another case, when the temperature changes very quickly, and there is no night man at the chute, the undercut gate freezes tight. I would like to know if there is any way these difficulties can be eliminated.

Mr. Abbott:—I had charge of the excavating of the pit in our Lorain plant. We went down into very hard clay to a distance of about 16 feet. We encountered water down about 10 feet and we had to keep it pumped out. It was a very difficult job and I made up my mind if we dug another pit we would not dig it anything like that depth. We put in there to drain it a sewer pipe, right in the bottom, running it out through the bank to the river slope. We were so situated that we could do that, running about a couple of hundred feet and drained off into the river, so that we have our pit drained from the bottom, and there is no danger of freezing. At Canal-Dover, when we put that in we did not put our pit down 16 feet, but only about 4 or 5. We have a little sloping trestle which comes up to it. We adopted the old plant in a certain way. We have no trouble with the water freezing now.

President Kittredge:—Have you had any trouble with chutes freezing, as mentioned by Mr. Hart?

Mr. Abbott:—Most of the repairs we have had to make have been in connection with the link-belt arrangement. We have now and then put in an extra link, but it is only a question of five minutes. We have half a dozen or so on hand all the time.

Mr. H. F. Baldwin (Chicago & Alton):—On the Alton road we are now installing ten coaling stations, and we have tried to do some things that are not mentioned in this report. At the intermediate coaling stations we have invariably opened a water and a coaling station. We have so located the water tank or the standpipe that a locomotive, when it stops to take coal, may at the same time take water. That we have accomplished by putting two spouts on the tank, for taking water from the tank, or by putting in a standpipe with a long spout that can be swung in either direction, so that no matter which direction the locomotive is headed, it may get water when it stops for coal. At those places we have one bin holding 60 tons of coal, so that there is only one place that a locomotive can get its coal. The arrangement we have saves a good deal of time in taking coal and water, and by the combination of coaling and water stations the same attendants who elevate the coal also pump the water. At the terminal stations we have made it a point to combine the handling

of sand and cinders and coal so as to reduce the attendance as much as possible. Those stations are all new; some of them are not in operation yet, and I cannot give the figures as to just what it is going to cost, but we think those are good points to combine. In addition, our management is very anxious to know how much coal each locomotive gets, and we have mounted these 70-ton bins on platform scales and we weigh off each locomotive the amount of coal it takes.

Mr. C. S. Churchill (Norfolk & Western):—I would like to ask the gentleman who just spoke in regard to this weighing of coal. I have made some inquiries about this recently, because we have before us just now the question of building new coaling stations. I have asked the question of a number of railroads and find them gradually abandoning the weighing of coal. We used to weigh it, but we have for a number of years estimated the weight. Take the plant just described. When you are dumping coal into your engine, do you not have to stop the bringing up of coal into your chute?

Mr. H. F. Baldwin:—We do; yes, sir.

Mr. Churchill:—So with a terminal yard I do not see how that can be arranged.

Mr. H. F. Baldwin:—The capacity of the machinery is 60 tons an hour, and our largest coaling stations use about 300 tons in 24 hours, so that it does not interfere at all with the handling of the coal.

Mr. Churchill:—When you want to get 500 tons a day it is not economy to work the hoisting plant 24 hours. You would like to do your hoisting and storage of coal in 10 hours. Then, if you do that, you are brought down to stopping every time that you weigh out your coal. I want to know what the practice is about weighing coal, whether it is regarded by people in the Association as necessary to weigh coal, or to estimate it.

Mr. H. F. Baldwin:—I might say, with reference to stopping the machinery, that that does apply at intermediate stations where we have only one pocket. At terminal stations we have two, so as to take coal from one while dumping coal into the other. That does not interfere at all with the operation at the terminal stations. At the intermediate stations the consumption is about 200 tons a day, less than two hours' work for the machinery. So that we do not consider that a serious matter at all.

Prof. Allen:—In relation to the matter of weighing coal, I have had the opportunity within a year or two of hearing the matter discussed in a railroad club where the master mechanics or the people who deal directly with coal were at hand, people who were immediately interested, and the opinion advanced there seemed to be, and it appeared to have a good deal of force, that in order to get the best results with your locomotive engineers you must not only weigh the coal, apportion the coal out to them, but it must be weighed or apportioned to them in such a way that they would feel confidence in your results, that they would feel satisfied that a fair weighing or rating was given them; otherwise than that they did not take the same interest and they did not feel that the burden was so definitely on their own shoulders. The opinion expressed in that club was in the direction of weighing in such a thorough way that the men would feel confidence in the weighing, and it seems as if that is an important feature.

President Kittredge:—It would seem to me, if you expect accurate information as to the performance of engines, it would be absolutely essential to know exactly the coal consumed, and so far as my experience and observation go, those who give that branch of the service special attention are particular in desiring coal to be weighed accurately.

Mr. Cushing:—In regard to the matter about which Mr. Allen speaks, on roads where there is a coal premium in existence, or where a special record of coal consumption is kept, not only does the quantity of coal in the tank have to be taken when the run begins, but also after the run ends. As a matter of fact, what coal remains in the tank is not and cannot be weighed. The result is that in taking such records the tank is marked in such a way that the capacity of different depths of coal in it is given after proper calibrating in advance, consequently weighing of coal at coaling stations has no bearing whatever on that record.

President Kittredge:—Mr. Cushing's remarks seem to be pertinent provided the engine starts on one tank of coal and does not take any coal until the end of the run is completed, but if an engine starts out from one terminus with a full tank of coal and practically empties that and fills up the tank at one or two other stations before it reaches the other terminus, it would seem to me

necessary to know how much had been added in the meantime to tell exactly what the man had used.

Mr. Cushing:—That is done by the capacity of the chute, or, in case dump-cars are used, by the capacity of the dump-cars, and both are known very accurately.

Mr. D. D. Carothers (Baltimore & Ohio):—Where you have a coal chute of the capacity of 500 tons it would be very difficult to estimate the quantity of coal taken. From the ordinary old-fashioned chutes we could arrive at a very close approximation, but it is difficult to estimate if it is taken from a chute containing such a quantity of coal. It seems to me it depends a great deal upon the manner in which the locomotives are run on a railroad. If a man is kept on a locomotive, as he is on many of the railroads, you can keep a record for the man as well as for the engine for a given time and check up the amount of coal used for the number of miles the locomotive has run. Of course, if the locomotives are changed or the engines are changed every trip it would be of very little value, and I think that is the way most of the railroads are running. A few years ago the road of which I had charge of the Maintenance-of-Way Department went to a great deal of trouble and expense to construct coal chutes with arrangements for weighing. This was entirely abandoned last year, as it was found of very little benefit, and at the present time the Baltimore & Ohio road does not weigh any coal going into the locomotives on any of its lines.

Mr. Churchill:—The Committee has published a plate of a coaling chute, "Hunt's proposed elevator," for Waterloo, Ia. I would like to know what the estimated cost of that is. That embodies, I notice, room for coal, room for sand and room for ashes, and the three go together. I have looked into this matter and find when the three go together a good many questions are raised. About ashes, I understand the link belts get hot, and as a result get warped, and there is a good deal of expense in maintaining the belts, so that some are recommending buckets instead of belts for disposing of ashes. Of course, sand can be handled in belts all right, the same as coal. I would like to know if the Committee have the approximate cost of that plant.

Mr. Parkhurst:—I would say with reference to the use of machinery, that the Hunt type is a series of buckets. The ashes

would be discharged into a very large hopper, where they would be wet down, and would be held there until the time came to run them into the conveyor, and they would probably be handled in the same way as coal. This was estimated to cost nineteen to twenty thousand dollars. This includes storage, as I recollect it, of about 3,500 tons, with all the appliances for handling ashes and sand, as well as for coal, and that includes the engine operating the plant, but without any boiler power, on the assumption that steam would be taken from the other boilers.

Mr. Cushing:—I would like to ask Mr. Parkhurst if in his link-belt plants he has had any trouble in handling ashes during the very severe cold weather, from the water that is used to wet the ashes down.

Mr. Parkhurst:—I would say we have; yes, sir. The plant which is illustrated in the paper and is in use in this city, at Twenty-sixth Street is provided with two long ash pits, into which the ashes are discharged, and from which they are handled by screws, which elevate them and direct them to a conveyor that carries them up to bins, into which they are stored, and then dropped into cars at will. The men who handle the plant are cautioned to be very careful about the use of the water in cold weather. The plant was finished in December or January and put into use, and the coldest weather we had was immediately afterward, and they froze up and tore the machinery pretty badly to pieces. There was considerable expense for repairs on account of that, and we have always had trouble and always would on such a plant. It has been proposed to modify the plant and substitute an entirely different method from the screws for handling the ashes. They work unsatisfactorily in cold weather. There is no trouble in warm weather, except the wear of the plant. The wear is very hard in the case of ashes.

Mr. Cushing:—Would you anticipate any trouble with the buckets of the Hunt style?

Mr. Parkhurst:—I think not. In the plant as designed, ashes were proposed to be wet down pretty largely under cover and where they could be kept from freezing. The ash pits in use now are out in the open air and fully exposed on the lake front, where they get the full benefit of the cold winds.

Mr. W. J. Harahan (Illinois Central):—From the drift of

the talks which have been made it would seem that it is very largely the opinion that the mechanical plant is the best plant. I think it depends very largely on conditions. We made an investigation last year to determine what character of plant was best for adoption as our standard coal chutes. After going into the matter very thoroughly, we determined that where there is no storage, or very little storage, that the old-fashioned plant is about the best plant. One of the principal advantages of the old-fashioned plant is that there is no machinery about it and nothing to get out of order, as there is in a mechanical plant. We have a mechanical plant at Twenty-seventh Street, put in several years ago, but which is not, I believe, quite up-to-date—in fact, I know it is not equipped with all the improved appliances that the link-belt people have now. We have had a great deal of trouble with this plant on account of its being out of service. A statement of the cost of handling coal at this plant is given in the report of this Committee. You will note it seems to be very much in excess of what is given as the cost of handling coal by some of those who have just given the cost of handling coal at some of their plants. The reason for this, however, is the fact that we use very few dump-cars, unloading most of our coal out of ordinary coal cars. It seems to me that the principle of the old-fashioned plant, especially where you have little storage, is correct. In the old-style plant you unload the coal direct from the cars into the pockets through which it is handled to the engine, while in the mechanical plant you not only unload the coal from the cars, but you afterward have to elevate it to the same pockets above mentioned. At places where there is a very large quantity of coal stored, however, this does not cut so much figure.

President Kittredge:—Will you please explain what you mean by the old-fashioned plant?

Mr. Harahan:—I mean the old-fashioned plant, incline, with ordinary pockets, so that the coal can be shoveled directly from the cars into the bins, or can be handled by side dump-cars into the bins.

Mr. McGuigan:—The question of the cost of handling coal is quite a serious one with us, and we are giving it a great deal of consideration at the present time. We have seventy-five different points at which we regularly deliver coal to engines, and our cost

varies all the way from 3 cents to 60 cents per ton, and we are quite anxious to learn the best practice. I have gathered some information from the statements of the gentlemen who have spoken on the subject. We agree with Mr. Harahan that, where we have the old-fashioned chutes or pockets, which suit the capacities of our engines, we can handle coal cheaper with dump-cars than any of our friends report. We have handled coal from dump-cars at a cost of considerably less than two cents, but our average cost with the same plant, sometimes having to shovel 25 to 40 per cent of coal, has been in the neighborhood of four cents, and, as Mr. Allen has suggested, there are situations in which we believe the reasonable cost of the establishing of a mechanical plant would justify an additional expenditure.

Mr. W. L. Breckinridge (Chicago, Burlington & Quincy) :—One point in regard to handling coal is the necessity for breaking it for engines in fast service. The machinery devices at present time will not do this. In our present chutes the self-unloading cars are set on a track 32 feet above main track rail. The coal falls from them on a grating, where it is broken by hand. This is the only manner in which we have been able with self-unloading cars to get the coal the proper size for engine service. This does not apply to coal for yard engines.

Mr. J. P. Snow (Boston & Maine—by letter) :—The layout and capacity of coaling stations should be governed very largely by the way in which a given railroad obtains its coal supply. If a mine is owned by the company a fairly regular supply at each coaling point can be depended upon, and but little storage is needed. If the coal is obtained by train shipment, more storage must be provided. If the supply is by water, as obtains with many roads in the East, a large storage and reloading plant at the receiving point is advisable and small capacity at the various coaling points is admissible.

Large storage capacity is not compatible with cheap installation and the most economical methods of delivery to engines, hence coaling stations, for service under normal conditions, should have but little storage, say three days' supply where a mine is owned or a large amount stored at a receiving port. If the supply is by train shipment from other roads, it is imperative that additional

storage be provided, but as this will be drawn upon only occasionally it need not be handled by the regular system of delivery.

It follows, then, that (if the amount of coal handled per diem warrants it) the most economical method of delivery to engines, viz., simple chutes filled direct from ordinary coal cars run up to the requisite height on a trestle incline, should be used for the normal everyday business; the chutes to be supplemented by a storage heap of a capacity of three days' consumption or more, according to the source of general supply; this storage to be delivered to engines by means which must be cheap in installation, but, of course, not so economical in operation as the regular method.

Plans 3 and 4 of the report cover the above idea, except that the cost of the installation for rehandling the stored coal is the greater part of the cost of the plant. Three methods for doing this work are submitted below, which are certainly not expensive in first cost, and actual experience shows their cost of operation to be reasonable when it is considered that this coal is to be used only when there is a break in the regular supply.

With the chutes suggested above, a convenient place for storing surplus coal is under the approach trestle, which may be covered in and roofed or not, as thought best.

One method of delivery is by locomotive derrick. This is a light pivoted crane with mast about 24 feet and arm 8 feet, set at the edge of coal pile, with a sheave in the step and a line run alongside the track to a snatch block with a hook at the proper point, so that when hitched to the side of a tender the engine in moving opposite to the derrick will have raised a tub to the proper height for dumping into the tender. The tubs used on the Boston & Maine road hold one-half ton and one ton, the smaller being preferred. They usually have truck wheels built into their bottoms and run very easily on the floor of the coal bin. The larger ones are sometimes set on low push cars, which run on tracks laid in the floor. These tubs are filled by shoveling from the pile and pushed under the derrick.

The second method is the same, except that the derrick is operated by a small hoisting engine, instead of by the locomotive. The hoister may be electric or a gasoline engine, requiring no attention when not in use.

The third method is similar, except that instead of a fixed derrick, requiring the tubs to be brought to it, a light boom with a hoisting engine is rigged on a flat car, which runs on a track between the engine track and coal pile and hoists the tubs.

The first of these methods is the cheapest, costing not over \$700 complete with ten tubs. Its objection is the time taken in filling a tender. With the half-ton tubs a single line is used, giving the engine a movement equal to the rise of the tub. With ton tubs and larger the tub is hitched to a single block running in a bight, the end of the line being fast to the arm of the crane. In this case the engine movement is twice as great as with the light tub. The cost of operation is approximately twice what it is with chutes. Generally the same force will suffice to operate this outfit as is required to attend the chutes, as when the stored coal is being used there will be, of course, no cars to unload.

As the report states, the storage of coal in cars is expensive, and, moreover, it is unbusinesslike. It will be still more expensive when cars are charged to foreign roads per day instead of as at present by mileage. With a storage bin adjacent to the chutes there need be no unreasonable holding of cars if the supply is properly adjusted to the force kept at the station. What is said in the report about the demand for cars in commercial service at certain seasons is appreciated, but it is submitted that good business management will furnish sufficient equipment to provide a regular supply of coal, barring unavoidable contingencies. A certain amount of storage is absolutely necessary, but sometimes the mistake is made of overdoing this feature by providing very large capacity and fitting it up with expensive means of rehandling, when, if properly managed, the stored coal need be used but seldom, and then for but short periods. Plan 7 of the report, for instance, puts all the coal through the storage bin. The operation of such plants may be fairly economical, but the first cost is excessive. They are on a much larger scale than is needed for daily deliveries.

For coal stations too small for chutes the favorite method on the Boston & Maine road is the locomotive derrick, as described above. These stations are generally at small termini, where the engines have ample time in which to take coal.

For larger stations the method generally adopted in the past, and now being built to some extent, is to dump the coal from an

elevated trestle into a shed holding from 3,000 to 10,000 tons, and delivering to engines something as shown in plan No. 1 of the report. Tracks for the delivery cars are three feet gauge, they are laid longitudinally in the house about ten feet apart and at some central point a cross track is laid, having plate iron turntables about 5 feet in diameter at the intersections. This cross track leads out to a transfer car made of rails and angle iron, which carries the dump-car parallel to the shed and sets it on any one of the series of tracks which end on the engine track in position to dump the car into the tender, as shown in the report. A scale is placed at the outlet of the coal shed, either under the transfer track or between it and the coal shed, so that each car may be weighed as it comes out. Any number of cars may be used, but there should be as many standing tracks between the transfer and the engine track as there are cars. The cars are made especially low for convenience in loading from the floor.

At these stations and those where the locomotive derrick is used for regular delivery, spouts are built for running coal directly from the cars on the trestle to the tubs or dumps on the floor of the shed; by this means shoveling is avoided when the supply of cars is regular and the cost of operation is but little more than with chutes.

Some kind of conveyor system for raising coal must be substituted for the approach trestle, of course, at points where a long incline is inadmissible.

Plan 10 of the report shows a style of hopper radically different from most of those in common use, in that it carries more coal than is delivered at one time to an engine. This means that a gate or valve must be arranged for stopping the run of coal before the apron of the chute is raised. A successful valve that can be operated by one man is a desideratum. Some years ago the Boston & Maine road had a hopper some 175 feet long, which carried about 700 tons, delivering by 36 chutes having valves, operated by compressed air. The hopper was supplied by a cable road taking coal from a grab shovel tower, which raised it from vessels lying at the wharf. If worked to its capacity, some 600 tons per day, the cost for labor from the vessel to the locomotive was less than 3 cents per ton. The plant was destroyed by fire after two or three years' use.

A large amount of coal behind each chute is desirable on many accounts. A little additional elevation of the coal costs but little and it adds greatly to the capacity of a hopper, as the addition is at the top. Unloading from cars is much more cheaply done if a whole load can be dropped into one bin than if the car must be moved to several. The cost of the building will be much less if its capacity is increased by adding to its height instead of its length and the cost of operation will be the same if a satisfactory valve is provided.

An ideal scheme, not mentioned in the report, for handling a central storage and distributing supply where coal is received by vessels, is similar to the ore-handling plants at several ports on Lake Erie. The unloading shovel should be of the clam-shell-grab type, delivering into cars on a track at the edge of the wharf or beyond into a storage heap of any desired size, the bridge and operating machinery to move along the wharf as vessels or the storage heap requires. If it is desired to coal engines near by, a line of chutes can be built and supplied by cable cars running under the shovel track, or engines can be coaled directly by the shovel if time can be spared while discharging vessels. The shovel can work from the heap when there are no vessels to be discharged. With a generous storage of this kind there need be but small storage at the outlying plants.

The question of weighing coal to the engines is not touched upon in the report. There is much difference of opinion on this matter, and a full report of the practice and opinions of the members of the Association would be valuable. With us the practice is not insisted on at present so much as formerly. With chutes it is difficult to weigh, but with the dump-car or tub systems described above it can be done with accuracy and no trouble.

Thomas Appleton (United States Life-Saving Service, by letter):—Coal for locomotives costs from one to three dollars per ton, and if the expense of taking coal from the cars and placing it upon the tenders amounts to 25 or 30 cents per ton, it is quite a percentage on the original cost. In seeking to reduce their fuel expenses, railroad managers have undertaken to decrease the cost of handling, by installing various mechanical devices for transferring coal from cars to tenders. These devices are of many

different kinds, and have been built with different ideas in view, and much ingenuity has been shown in their construction.

The handling of wheat and other grains by modern American elevating machinery is accomplished at a very small cost per bushel, when dealing with large quantities. The success of this grain-handling machinery has led some railroad men to undertake the handling of locomotive coal by similar apparatus. But grain and coal are very dissimilar. Wheat, for instance, comes in small grains, of practically uniform size, rounded and smooth, not fragile or likely to be injured by dropping any reasonable distance or by friction. On the other hand, coal is of all sizes, from dust to lumps of a half-bushel size, it is irregular and angular in shape, it is fragile, so that dropping it any distance will break up the lumps, making a large percentage of undesirable dust. When anything like a chain conveyor is designed for handling run-of-mine coal, the buckets must be large enough to carry the largest lumps without clogging, and tight enough to convey the finest dust without leakage. They must be made strong enough for the heaviest loads, although they may be running a greater part of the time less than half loaded. Such chain conveyors have been constructed, and they are fine examples of mechanical ingenuity. The best of them require some sort of loading machine to control the delivery of the large lumps and maintain a somewhat even distribution of the coal on the chain or belt. Any successful conveyor of this kind must be a costly piece of machinery, and, as its buckets must be of large size, its capacity will be so great that its use is warranted only where large quantities of coal are required daily. For instance, if the daily coal supply from a given station does not exceed forty tons, it would be absurd to install a coal-handling plant with a capacity of 100 tons per hour. Interest on the first cost is a very important item of expense, sometimes overlooked, but eternal and inexorable in its demands.

A coal-handling plant on a dock at one of the great lake ports was shown to the writer. Its purpose was to unload coal from vessels expeditiously, store it upon the dock, and load it upon cars, as required. It was a beautiful example of mechanical design, finely carried out. It would handle coal at a cost of six cents per ton, but the annual interest on the cost divided by the quantity actually handled per year, amounted to 50 to 75 cents per ton.

The railroad engineer, in planning coaling stations, should avoid such mistakes as that.

Any coal-handling plant which requires the shoveling of coal must start with an expense of from six to ten cents per ton, for each handling. When coal is hauled in dump-cars or hopper-bottom cars, the cost of unloading from cars is quite small. Some would say that coal should never be hauled in any other cars. Where coal, coke or ore constitute a large part of the freight traffic, it would be foolish to put coal into box cars. It is troublesome to get the coal into the cars in the first place, and costly to get it out again. Besides, the car is likely to be held out of revenue-earning service while the tedious process of unloading is going on. But some railroads have a large grain traffic east-bound to the lakes, and a moderate coal traffic westbound from the same points. Should all these grain-laden box cars be sent west empty, and a special lot of coal cars be purchased to haul coal west and return east empty? The manager will usually figure that it is cheaper to handle coal in box cars in such cases, rather than to have so much empty car movement, to say nothing of the interest on the cost of the special coal cars. This will certainly prove true of any long distances.

Hence, in designing a coal-handling plant, one of the first things to be considered is the kind of car in which the coal is to be received. If hopper-bottom cars are used the top of the coal pile must not be higher than the top of the rail. If the coal is shoveled out of box or gondola cars, the top of the coal pile may be as high or higher than the floor of the car. In the one case the apex of the coal heap will be under the center of the track, while in the other case it would be six or eight feet on either side of the center of the track. Coal will slide on a surface inclined 35 degrees or more from the horizontal. So if coal once be placed at a sufficient elevation it will move itself, without expense, in a vertical or sloping direction, any desired distance.

Coaling stations may be divided into two general classes, a terminal station, and a roadside station, where it is necessary to replenish the fuel supply of a locomotive on a long run. In the former a large quantity of coal is handled, switch engines, steam or electric power and laborers are available, and there is plenty of time in which to coal the engines. In the latter case the quan-

tity of coal handled per day is usually comparatively small. the power, switch engines and labor are absent, and every second of delay counts. The requirements of fast through trains will not permit of any unnecessary stops, and those which must be made should be as brief as possible. If the engine can take coal and water and get under full speed again with a total loss of two minutes' time, it is a great gain over a seven-minute delay. For a fast through train it will not do to hoist coal onto the tender in half-ton buckets with a derrick—it must come down on the tender four or five tons at once, like an avalanche. And to digress a little, at the same point, it will never do to take a drizzling water supply through a four-inch valve, at the rate of 200 or 300 gallons per minute—the water must come down as if the bottom had been knocked out of the tank, 3,000 gallons in half a minute.

For the roadside stations the well-known "Clifton" or "Williams & White" coaling stations are extensively used and very efficient. With them the three, four or five tons wanted comes down with a rush, and if the fireman miscalculates the quantity required some of it will spill on the ground, but he gets his coal quickly. To have the coal run freely the end of the apron must be high enough to permit the entire lot of coal to "cascade" over the end of the apron. If the coal on the tender piles up around the end of the apron it will have to be dug out with a shovel before the apron can be put back in place. For quick action there must be some risk of spilling coal on the ground. Some coaling stations are fitted with gates at each apron, to cut off the flow of coal when a sufficient quantity is received. Such an apparatus requires a narrower opening, and it will take an appreciably longer time for the coal to flow to the tender. It would be quite desirable at a terminal station, but less so at a roadside point, where loss of time cannot be permitted.

There seems to be a difference of opinion as to the necessity of weighing out the coal to each engine. Many railroad companies attempt to keep records of coal delivered to each engine at each coaling station, but oftentimes much of it is rank guesswork. Usually the amount of coal left on the tender at the end of a day's run is guessed at, sometimes it is estimated by leveling off the coal to certain marks on the tender. But if the coal be accurately weighed onto the tender, only one-half as much guesswork

will be required as when it is guessed on and guessed off. If this weighing can be correctly done, without appreciable loss of time, and without increase of expense, it will be considered quite desirable to do so. To be useful such a weighing apparatus must be simple and strong, reasonably accurate, not likely to be easily put out of order, and capable of being operated by an ordinary laborer. Probably a weighing apparatus which can be quickly balanced to show the weight of coal in the pocket before coal is taken, and then weigh the amount of coal taken by a negative scale beam, will best fill the requirements. The coal pocket must hang free, its action must not be clogged by small lumps of coal getting wedged around it. Unless the weighing can be accurately done it should not be done at all.

The derrick and bucket apparatus, which has been much used on Western roads in the past, has some advantages. It provided a considerable storage space, the half-ton buckets measured the coal with some approach to accuracy, and it placed the coal just where it was wanted on the tender. Very rarely was any spilled on the ground. It was expensive, in that all the coal had to be shoveled into the buckets, and it was slow—the engineer running a limited train ten minutes late realized how slow it was. Usually the section crew were required to fill the quota of coal buckets and hoist them to a platform level with the top of the tender, so that a single man could swing the buckets onto the tender, as required, with the assistance of the fireman.

There are many intermediate points where through trains must replenish their coal and water supply. At many of these points there is no switch engine employed, and it is not desirable to take the freight train crews to set coal cars up onto the coal trestle. Generally a water tank is located at such a point and some pumping power is required to keep the tank filled. Gasoline engines are much employed for pumping water, and it is customary to make the pump man attend also to the coal chute. An engine of three to five horsepower may be sufficient to do the pumping, and a larger sized engine could be set to work handling coal also. The report of the Committee on Buildings shows an illustration of a coaling station used on the Great Northern Railway, which is planned for such a scheme. The station has a high trestle, some 33 or 35 feet above the main track, with a steep

incline; 20 per cent grade was generally used. This makes a short incline and hence economizes material as well as space. The engine hauls a loaded coal car up the incline, by means of a wire rope on a drum geared to a slow speed, and through a counter shaft operates the pump for supplying the water tank. A fifteen-horsepower engine will haul a car loaded with 60,000 pounds of coal up this 20 per cent incline at the rate of 13 feet per minute. It takes 25 or 30 minutes to get a car from the foot of the grade to the dumping place. This looks like a slow speed, but if there are only two or three cars to be unloaded in 24 hours there is no reason why the car should be pulled up faster. Of course, a more powerful engine would take the car up quicker, and if more than 100 tons per day were to be handled it would be desirable to save some time in the hauling. In order that the empty car shall pull the rope off the drum a grade of one or one and a half per cent is necessary, even on top of the coal pocket. As built on the Great Northern System, there were storage pockets just above the coaling pockets, these storage pockets holding enough to fill the coaling pockets twice, so that ordinarily it would not be necessary to hoist any coal cars after dark. The winding drum had a strong ratchet and pawl, to guard against accidents while hoisting, and a heavy brake, to control the descent of the empty car on the 20 per cent incline. One man could perform all the operations necessary for hoisting a loaded car, but it is better to have another man assist him in pulling the slack rope off the drum and coupling onto the car. One of the section crew could attend to this once or twice a day.

If steam power is used for hoisting and pumping, it is necessary to have a competent attendant constantly with the boiler, to keep up steam and water. With a gasoline engine the attendant can leave it for hours at a time. Hence, for small powers the gasoline engine is economical as to wages. But the man who operates a gasoline engine should have some mechanical gumption; a common laborer should not be trusted with machinery. There has been some prejudice against the use of such an inflammable material as gasoline for power purposes, but a well-built gasoline engine, properly installed, is as safe, if not safer, than a steam boiler. No gasoline should be kept or used in the engine-room, excepting that which is inside the cylinder and pipes. The

gasoline supply should be in a tight metallic tank, outside the building, placed low enough so that the liquid would run back to the tank when the engine stops. The piping should be planned so that it will be very inconvenient for anyone to get any gasoline out of the apparatus. Where these rules are kept in view the insurance inspectors will not object to the use of gasoline engines for power.

The writer cannot speak from personal experience of the many well-designed coal conveyors which have been erected in recent years. There are many places where the quantity of coal handled would make it economical to employ such plants. The use of the coal-conveying apparatus for handling cinders is looked upon by many as of doubtful economy, when the cost of the necessary pits and outfit and the effect of either hot or frozen gritty cinders are considered. Shoveling from the cinder pit into cars on a depressed track is generally favored. In this connection it would be well to bear in mind that if the engine track on the ash pit can be raised a foot or two from the grade of the yard the depressed track will not have to go down so deep as it otherwise would. The same principle would apply to coal-dumping pits, where a conveyor is used to elevate the coal from the dumping pit to the pocket. Often it is exceedingly difficult to get good drainage for coal pits, cinder pits, turntable pits, etc.

A word as to storage of coal. On account of the irregularity of traffic, as well as the uncertainty of a regular coal supply, some coal storage is almost absolutely necessary at every coaling station. Holding cars loaded with coal is extravagant and demoralizing to transportation employes. To make a storage bin at a height where the coal will slide down into the coaling pockets requires costly construction. There may be no available space adjacent to the coaling station. It might be well to build a high trestle, say, 20 or 25 feet above yard grade, at some out-of-the-way point within the yard limits, where coal can be dumped from time to time, whenever there are loaded coal cars not wanted at the coal chute. This coal can be loaded into hopper-bottom or dump cars, and switched to the coal chute when the regular supply runs short. When the company's steam shovel is not in service it could be used to load coal cars from such a coal pile, or a traveling steam derrick with a clamshell bucket could be used. This storage

pile should be protected from the weather by a shed roof, so constructed as to permit the use of the steam shovel or derrick for loading cars.

President Kittredge:—The subject of railroad water tanks is now open for discussion. Has Mr. Parkhurst anything to say in addition on the subject of water tanks?

Mr. Parkhurst:—I think it is hardly necessary to say anything, except that this is simply a record of progress, and presents drawings and tabular data on the general subject without making any recommendations at all.

Mr. Cushing:—Mr. President, as the method of procedure in working in this Association is exceedingly important and always a live subject with us, as a good many of us do not feel we have entirely solved the problem yet, I would like to say that I think this report of the Committee is a very excellent one indeed, and very pertinent to the work which we have in hand, viz., the gathering of information to present to the different members of the Association for our information, so that we may become posted on what each one is doing. This is a distinct style of report, which I think is one of the important works of this Association. I move the acceptance of the report as a whole.

(The motion was carried.)

Recess until 2 p. m.

### WEDNESDAY, AFTERNOON SESSION.

The meeting came to order at 2 p. m.

President Kittredge:—The next committee is that on Rail, of which Mr. Trimble is chairman. This is considered one of our most important reports, and I have delayed calling the Committee forward until now, so as to get as many members of the Committee present at the meeting as possible. The Secretary will call the names, and as many of the Committee as are present will please come forward. Mr. Trimble will introduce the subject as he sees fit.

## REPORT OF COMMITTEE No. IV.—ON RAIL.

*To the Members of the American Railway Engineering and Maintenance-of-Way Association:*

We submit the following report:

The Board of Direction asked that the report be confined to one or two of the subjects before us. In accordance with this recommendation, we stated that in our judgment two of the most important subjects to be reported on were Rail Sections and Specifications.

It might have been better to have stated these subjects thus: Rail Sections and Process of Manufacture.

In naming Specifications as an important subject, we had in mind, however, a specification that would cover the process of manufacture better than any specification now in general use.

The above subjects were selected not only on account of their importance, but also for the reason that it is desirable that the railroads agree on a uniform practice in these matters.

## RAIL SECTIONS.

The rail mills have furnished the percentages of their total output of rails rolled to A. S. C. E. Section, during 1901, as follows:

National Steel Company .....	95.0	per cent.
Pennsylvania Steel Company.....	93.2	"
Illinois Steel Company.....	70.0	"
Cambria Steel Company.....	73.5	"
Carnegie Steel Company.....	72.0	"
Maryland Steel Company.....	52.1	"
Lackawanna Steel Company.....	37.2	"

The low percentage of A. S. C. E. output from the Maryland Steel Company is explained by the fact that a large amount of rail of special pattern was rolled for export; also that the Pennsylvania Lines East of Pittsburg and the Baltimore & Ohio Railroad Company used special patterns.

The Lackawanna Steel Company rolled a large tonnage of the Dudley pattern for the New York Central Lines.

We referred in 1901 to some difficulties which were encountered at the mills, due to finishing the rails at a lower temperature, and suggested that it might be necessary to modify the heavier sections in common use, especially the A. S. C. E. sections, which have come into wide use. The difficulties still exist, and in our opinion sooner or later some changes will have to be made, either in sections, or in the mill practice in rolling.

It was suggested at our last meeting that the sections should not be changed without taking up the matter with the American Society of Civil Engineers, and since that time that society has decided on the appointment of a committee on rail sections, which should summarize the present state of the art of rail-making and cover an investigation of all ques-

tions relating thereto, whether of sections, composition of the material or process of manufacture. The personnel of this committee has not been announced. It is hoped that it will be made up of men directly connected with the use of rails; also, that a long time will not be necessary to reach conclusions and formulate a report. We should coöperate in every possible way and freely furnish any information we can in the matter.

We are fully aware of the number of committees that have been appointed from time to time to report on the chemical composition of steel, the methods of rolling to make a first-class steel rail, and that there has been a great deal of time and work expended on this matter by these committees. Some of the reports have gone into the subject very fully, and at the conclusion have recommended that the metal should receive more work at the proper low temperature. This recommendation has not been adopted by railroad companies because the mills have asked a higher price per ton for the rail; instead, they have continued to buy rails of poor quality, and often without any tests or inspections whatever being made.

We think we fully appreciate that in asking the manufacturers to improve their methods of rolling and give more care and attention to the manufacture of rails that the railroad companies should be willing to share in any additional expense if such be necessary.

We know there is no use in trying to make a good rail by the chemical composition alone. The evidence clearly points to the fact that much better rails can be made from the steel now in use, provided it receives the proper treatment in rolling. We desire, therefore, to put ourselves clearly on record on this point, as it is a vital one and underlies the whole matter.

### SPECIFICATIONS.

We strongly advocate the use of a uniform specification and uniform methods of testing.

In our last report we submitted for the information of the Association the proposed standard specifications recommended by Committee No. 1 of the American Section of the International Association for Testing Materials, which have since been adopted by the American Section, at their annual meeting in June, 1901.

We now offer these specifications, with some amendments, for use by the members of this Association. These specifications are not entirely satisfactory to us, but in order to take a step toward uniformity we advise their use instead of waiting for a perfect specification. Any additions or modifications needed which may develop from an actual test may be made as necessary.

**PROCESS OF MANUFACTURE.**—Details of processes of manufacture have generally been neglected, except in the one aim of the mill to turn out the largest tonnage in the shortest time at a minimum cost. We, of course, do not wish to find fault with this, as it has enabled the railroad companies to buy rails at a lower price, even if they do not wear as well as desired,

but if we are sincere in our demands for better rail, we must in the future pay more attention to these details.

It is conceded that the quality of rolled steel depends on its chemical composition and the heat treatment it receives in connection with the work of rolling, and in order to get the best results, steel of good uniform chemical composition should be used and rolled at a uniform low temperature, the ingot or bloom used being large enough to allow the work in rolling to break up the coarse grain, as it is not the total amount of reduction in rolling that produces the best results, but a sufficient amount of work must be done at the proper low temperature—the work at the higher temperatures merely changing the form of the mass without changing its structure.

The bad effects of too high finishing temperature are recognized by the rail manufacturers, some of whom are now rolling their heavier rails at a much lower temperature than formerly. We appreciate their efforts, and, as showing that the engineers were willing to meet the manufacturers half way, a change in the section of the heavier rails was suggested last year by increasing the thickness of metal in the flanges in order to carry the heat longer and allow the work of rolling on the head at the proper low temperature, provided the manufacturers found it necessary to make this change in order to produce the best results.

We take pleasure in calling our members' attention to the following papers that have appeared during the past year, as treating on the points referred to:

"The Correct Treatment of Steel," by C. H. Ridsdale, Iron and Steel Institute, Vol. 2, 1901; also abstract of same in Engineering News, Oct. 3d and Oct. 10th, 1901.

"Some Suggestions as to Specifications for Steel Rails," by E. F. Kenney, Engineer of Tests, Pennsylvania Railroad, in Engineering News, Oct. 3d, 1901.

"Rail Rolling at Lower Temperatures During 1901," by S. S. Martin, Superintendent Maryland Steel Company, in Iron Age, and reprinted in Railroad Gazette, Jan. 3d, 1902.

Editorial, Railroad Gazette, Jan. 24th, 1902, "Rolling Rails at Low Temperatures."

There is no use advocating any change of section or method of rolling unless we can have some reliable check that the rails are being rolled at the proper low temperature. At our last meeting it was suggested that the amount of shrinkage in the rail, after it has been cut at the hot saw, is the best and easiest method of checking the finishing temperature.

We note that the Pennsylvania Railroad Company, in their new Rail Specifications (October 1st, 1901), have embodied this shrinkage clause for a 30-foot rail, which we give below, modifying it for a 33-foot rail, which is our standard:

"The number of passes and speed of train shall be so regulated that on leaving the rolls at the final pass the temperature of the rail will

not exceed that which requires a shrinkage allowance at the hot saws of 6 inches for 85 pounds and  $6\frac{1}{2}$  inches for 100-pound rails, and no artificial means of cooling the rails shall be used between the finishing pass and hot saws."

**CHEMICAL PROPERTIES.**—The new rail specification of the Pennsylvania Railroad Company is as follows:

"The steel of which the rails are rolled shall contain not less than 0.40, nor more than 0.55, of 1.00 per cent of carbon where the phosphorus exceeds 0.07 of 1.00 per cent. Where the phosphorus is 0.07 of 1.00 per cent or less, the carbon shall not be less than 0.45, nor more than 0.60, of 1.00 per cent. The manganese in no case shall exceed 1.20 per cent, and where the phosphorus exceeds 0.07 of 1.00 per cent, the manganese shall not be higher than 1.00 per cent. Also in no case shall the phosphorus exceed 0.10 of 1.00 per cent."

It will be noticed that the carbon and manganese are decreased when the phosphorus is above seven-hundredths of one per cent, in order to give steel of an equivalent hardness, and at the same time to guard against the steel being too hard and brittle.

We are advised that the Pennsylvania Railroad Company now advocate higher carbons, as their drop tests show that rails finished at a lower temperature give a greater deflection than formerly, when finished at the higher temperature. They also find that higher carbons can be used with safety when the proper check is kept on the low-finishing temperature. They specify a deflection of not more than  $2\frac{1}{4}$  inches for 100-pound rails after the first blow.

We suggest that our members direct their rail inspectors to keep a record of the amount of shrinkage, with the results of drop tests and chemical composition of each lot of rails they receive. This information, with the results of the rails in service, will be valuable in making a final specification.

**TEST PIECES AND METHODS OF TESTING.**—The specifying of a drop test seems to be almost universally regarded as essential, and yet, unless the portion of the ingot from which the test piece comes is known, the drop test may be quite misleading.

The test piece should be taken from some designated location, preferably from what was the top of the ingot, for then we are reasonably sure that all the rails represented by that test piece are at least equal to, and probably better, than the test piece.

**TEST IN SERVICE.**—It is recommended that the following simple test be made by those interested in the wear of rails of different compositions and manufacture: Take a curve where rails are known to wear rapidly, and lay the different kinds of rail alternately. The rails are then acting under precisely uniform conditions, and it will take but a few months to determine what rail is giving the best results. If this experiment be made anew each year for a few years, the road making such a test would have valuable information, which will be useful in helping to decide on the kind of rail which will give the best results in actual service.

## PROPOSED STANDARD SPECIFICATIONS FOR STEEL RAILS.

## PROCESS OF MANUFACTURE.

1. (a). Steel may be made by the Bessemer or open-hearth process.
- (b). The entire process of manufacture and testing shall be in accordance with the best standard current practice, and special care shall be taken to conform to the following instructions:
- (c). Ingots shall be kept in a vertical position in pit heating furnaces.
- (d). No bled ingots shall be used.
- (e). Sufficient material shall be discarded from the top of the ingots to insure sound rails.

## CHEMICAL PROPERTIES.

2. For Bessemer Process.—Rails of the various weights per yard specified below shall conform to the following limits in chemical composition:

	50 to 59+ pounds. Per cent.	60 to 69+ pounds. Per cent.	70 to 79+ pounds. Per cent.	80 to 89+ pounds. Per cent.	90 to 100 pounds. Per cent.
Carbon .....	0.35-0.45	0.38-0.48	0.40-0.50	0.43-0.53	0.45-0.55
Phosphorus shall not exceed....	0.10	0.10	0.10	0.10	0.10
Silicon shall not exceed.....	0.20	0.20	0.20	0.20	0.20
Manganese.....	0.70-1.00	0.70-1.00	0.75-1.05	0.80-1.10	0.80-1.10

## PHYSICAL PROPERTIES.

3. One drop test shall be made on a piece of rail not more than six feet long, selected from every blow of steel. The test piece shall preferably be taken from the top of the ingot. The rail shall be placed head upwards on the supports and the various sections shall be subjected to the following impact tests:

Weight of rail. Pounds per yard.		Height of drop. Feet.	
	45 to and including	55	15
More than 55	"	65	16
" 65	"	75	17
" 75	"	85	18
" 85	"	100	19

If any rail break when subjected to the drop test, two additional tests will be made of other rails from the same blow of steel, and if either of these latter tests fail, all the rails of the blow which they represent will be rejected, but if both of these additional test pieces meet the requirements, all the rails of the blow which they represent will be accepted.

## HEAT TREATMENT.

The number of passes and speed of train shall be so regulated that on leaving the rolls at the final pass the temperature of the rail will not exceed that which requires a shrinkage allowance at the hot saws of — inches for 85-pound and — inches for 100-pound rails, and no artificial means of cooling the rails shall be used between the finishing pass and the hot saws.

## TEST PIECES AND METHODS OF TESTING.

4. The drop test machine shall have a tup of two thousand (2,000) pounds' weight, the striking face of which shall have a radius of not more than five inches (5"), and the test rail shall be placed head upwards on solid supports three feet (3') apart. The anvil block shall weigh at least twenty thousand (20,000) pounds, and the supports shall be a part of, or firmly secured to, the anvil. The report of the drop test shall state the atmospheric temperature at the time the test was made.

5. The manufacturer shall furnish the inspector, daily, with carbon determinations of each blow, and a complete chemical analysis every twenty-four hours, representing the average of the other elements contained in the steel. These analyses shall be made on drillings taken from a small test ingot.

## FINISH.

6. Unless otherwise specified, the section of rail shall be the American Standard, recommended by the American Society of Civil Engineers, and shall conform, as accurately as possible, to the templet furnished by the railroad company, consistent with paragraph No. 7, relative to specified weight. A variation in height of one-sixty-fourth of an inch ( $1/64$ ") less and one sixty-fourth of an inch ( $1/64$ "—see footnote page 212) greater than the specified height and  $1/16$ " in width will be permitted. The section of rail shall conform perfectly to the fishing dimension.

7. The weight of the rails shall be maintained as nearly as possible, after complying with paragraph No. 6, to that specified in contract. A variation of one-half of one per cent ( $1/2\%$ ) for an entire order will be allowed. Rails shall be accepted and paid for according to actual weights.

8. The standard length of rails shall be thirty-three feet. Ten per cent ( $10\%$ ) of the entire order will be accepted in shorter lengths, varying by even feet down to twenty-seven feet (27'). A variation of one-fourth of an inch ( $1/4$ ") in length from that specified will be allowed.

9. Circular holes for splice bars shall be drilled in accordance with the specifications of the purchaser. The holes shall accurately conform to the drawing and dimensions furnished in every respect, and must be free from burrs.

10. Rails shall be straight when finished, the straightening being done while cold, smooth on head, sawed square at ends, variation to be not over  $1/32$ ", and, prior to shipment, shall have the burr, occasioned by the saw cutting, removed, and the ends made clean. Number 1 rails shall be free from injurious defects and flaws of all kinds.

## BRANDING.

11. The name of the maker, the weight of rail, the month and year of manufacture shall be rolled in raised letters on the side of the web, and the number of the blow shall be stamped on each rail.

## INSPECTION.

12. The inspector representing the purchaser shall have all reasonable facilities afforded to him by the manufacturer to satisfy him that the finished material is furnished in accordance with these specifications. All tests and inspections shall be made at the place of manufacture, prior to shipment.

## NO. 2 RAILS.

13. Rails that possess any injurious physical defects, or which for any other cause are not suitable for first quality, or number 1, rails, shall be considered as number 2 rails, provided, however, that rails which contain any physical defects which impair their strength shall be rejected. The ends of all number 2 rails shall be painted in order to distinguish them.

## RECOMMENDATION.

We recommend that the above specification be adopted as standard for use of members of this Association, that it be printed and distributed to the members, and that the members of the Association obtain the information suggested in regard to chemical composition and shrinkage, and submit the same for use of the Committee on Rail, from time to time, as it is secured.

Respectfully submitted.

R. TRIMBLE, Pennsylvania Lines, Pittsburg, *Chairman*;  
J. T. RICHARDS, Pennsylvania R. R., Philadelphia, *Vice-Chairman*;  
THOMAS PURCELL, Mexican National, Matamoras, Mexico;  
A. W. JOHNSTON, N. Y. C. & St. L., Cleveland;  
C. E. WICKHAM, C. R. I. & P., Davenport, Ia.;  
R. W. HUNT, Chicago;  
G. B. WOODWORTH, C., M. & St. P., Chicago;  
F. E. ABBOTT, Chicago;  
WM. R. WEBSTER, Philadelphia, Pa.;  
W. T. MANNING, B. & O., Baltimore;  
H. PIERCE, C. & O., Huntington, W. Va.

*Committee.*

Mr. Robert Trimble (Pennsylvania Lines):—I think it probably better to read the report of the Committee. I would call the attention of the members to some changes that have been made in the report. There were some points on which it was hard for the Committee to agree, and we have had a meeting to-day and decided on some changes in the report, making it such that all the members, I think, are now agreed on the report as it will be submitted.

Colonel Prout, in an editorial in the Railroad Gazette, suggested that the Rail Committee of this Association might sit still a year and await the action of the rail committee of the American Society of Civil Engineers, appointed at its last meeting. The appointment of this committee was agitated at our last meeting, and we felt that it would be hardly proper for us to go very deep into the subject of making special recommendations in regard to

sections at this meeting. We think the advice given us is good, and that it is probably the part of wisdom for us to wait a little longer in this matter of sections.

A word in regard to the test in service. I have no doubt a number of railroad companies make such test or similar tests, and yet they do not feel that the information obtained can be given out, for reasons which will be obvious to you upon reflection. Without mentioning any manufacturers, I can say that we have made tests like this, using nickel steel, open-hearth steel and the steel of the regular product, and we have found that on curves of about 6 degrees a rail with about 3 per cent nickel, which has been in four years now, shows comparatively little wear as compared with the regular rail that we have been getting. The regular rail on the same curve has been turned, and we are now working the other side of the head of that rail. That test can be carried through by any person who wishes to make it. You can take a rail made as Superintendent Martin of the Maryland Steel Company recommends, and a rail made by the Kennedy-Morrison process, and put these rails alongside each other and find out what they will do. As to whether you wish to furnish the results of the tests for publication, or to the Association, is a matter you must determine for yourself.

As the practice in different mills, in regard to rolling, is different, we should not specify the same shrinkage for all mills. For instance, in the direct rolling as practiced by the Maryland Steel Company, it is claimed that they get the same results that are arrived at at the Carnegie works, using the Kennedy-Morrison process; but the shrinkage at the Maryland Steel Company, to get the same results that you get at the Carnegie Steel Works, would be different, and for that reason these blanks in the specifications have to be filled in depending on the mill where the rail is to be rolled.

In regard to the specifications, they are nearly the same as recommended by committee No. 1 of the International Association for Testing Materials. In section 3 we ask for a drop test on every blow of the steel instead of every fifth blow. We omit a portion of that paragraph, which will be stricken out on account of that modification of the number of drop tests. We have added the clause relating to heat treatment. We have added the one

which specifies where the piece for the drop test shall be taken; that is, from the top of the ingot. I move the report be adopted.

President Kittredge:—This is one of our important reports, and it might be well in discussing this report to discuss first the rail sections and then discuss the specifications, leaving action on the motion until after the discussion of both of the subdivisions.

Mr. Trimble:—Mr. Webster has called my attention to an addition that was made to the report of the International Association for Testing Materials, at their last meeting at Niagara Falls, in regard to the drop tests, which provides that: "The report of the drop test shall state the atmospheric temperature at the time the tests were made." The Committee would like to have that added to this report at the end of paragraph 4, on page 6 of the report.

Mr. W. McNab (Grand Trunk):—I ask if there have been any overtures made to, or by, the American Society of Civil Engineers in regard to this proposed section?

Mr. Trimble:—I can answer for the Committee, but I do not know what the Board of Direction has done in that matter. The American Society has been discussing that matter since our last meeting, and it is only recently that they have decided to appoint a committee. I believe the committee has been appointed, but not announced, and as far as our Committee is concerned, there was nothing done in regard to the matter, there being no committee of the American Society, and I do not know that it would be a proper matter for our Committee to bring to the attention of the American Society. That would be a matter for the Board of Direction of this Association to bring up with the American Society.

President Kittredge:—For the information of Mr. McNab, I would state that the Board has not discussed this question with the American Society of Civil Engineers, knowing that a new committee was about to be appointed, but had not yet been named.

If there is no further discussion on the rail sections, discussion on the specifications will be in order. Mr. Trimble, the chairman of the Committee, has some remarks to make about the specifications.

Mr. Trimble:—In regard to the specifications, we state on page 3 that these specifications are not entirely satisfactory to us,

but we think they are the best that can be had at the present time. Our reason for recommending the Association to adopt this specification at the present time is that we may get together and be able to work as a unit. Either at the last meeting or the meeting before, there was information given to this Association which indicated there were about 115 railroads buying steel rails without any specification. There was another large number of railroads that did not have a specification, but asked the mills to give them the same kind of rail that was being furnished to the Pennsylvania Railroad; then there were other roads which asked for the same kind of rail which was being given to some other railroad.

We feel that the specification which is offered here is one that the manufacturers can take no exception to, and if we make it a uniform practice for the Association we are simply taking a step toward uniformity. It may be found in a year from now that we will want to make an addition to the specification, and in two years from now we will want to make another addition, and we feel it is better to have a specification that is not perfect than not to have any at all, because if you get your perfect specification and try to put it in force at once, you may have more difficulty. It is our opinion that these matters can be better accomplished a little at a time than by trying to finish the whole thing at one time, and that is the reason we propose this specification at this meeting.

Mr. A. Torrey (Michigan Central):—I do not know anything about the application of open-hearth steel to the manufacture of rails. But if I do know anything about it, I hardly think that the same chemical composition used for open-hearth steel is the best. I think the phosphorus can be put lower and the carbon a good deal higher. The stipulation in the specification as to variation of heights, I think, should be  $\pm 64$  either way from the true section. If you put in such minute fractions, I think it should vary with the section which is called for under the specification. As to the branding, I think that generally indicates the weight of the rail, and it is my opinion that it should be included in the specification. It seems to be omitted from specification 11. The last part of stipulation No. 6 provides that: "A perfect fit of the splicebars, however, shall be maintained at all times." I presume that means a perfect maintenance of the fishing dimensions.

Mr. Trimble:—The Committee would have no objection at all to amend the report in that respect; that is, change the variation in paragraph 6 to 1-64 in either case, but there may be some difficulty about it in the mills.

Mr. Torrey:—I never experienced any difficulty about it in that matter.

Mr. Trimble:—That is one of the features in this specification which suits the mills possibly better than the railroads. We want to get the railroads to use this, and a little later on we can take a step to get a specification that fits the railroads better, and possibly not the mills so well. It is desirable to have as uniform a practice as possible. On our railroad we had some rails that did not vary much more than the specification permits. Our specification is probably the same, 1-64 and 1-32. In regard to adding the weight of the rail to the brand mark, we will accept that amendment to section 11.

Mr. Torrey:—The fishing dimensions can be maintained so as not to give any trouble in that regard.

Mr. Trimble:—I have found a synopsis of American rail specifications, and find that your road is the only road that provides 1-64, over and under. The other roads have 1-32 over and 1-64 under. I think we would all like to have it 1-64 both ways.

Mr. Torrey:—I received rails two or three years ago, and through some manipulation of the mill I got a batch of rails 1-64 under mixed up with a batch of rails fully 1-32 over, and the results were not satisfactory. I had to take them apart and fix them up, putting them in groups. I should like to be enlightened about the first point I brought out, as to the propriety and the desirability of using the same chemical specifications for Bessemer as for open-hearth.

Mr. Trimble:—I cannot answer the question very well, but have no doubt that Mr. Webster can. We have laid but little open-hearth rail on our railroads, and if I remember the composition correctly, the carbon was about 0.60,\* and the phosphorus was lower than 1-10 of 1 per cent. That is almost in substantial agreement with this specification. I do not know of any place where open-hearth steel is used except in small lots.

Mr. Torrey:—Would you think it advisable to introduce the

\*The actual composition is as follows: Carbon, 0.55 to 0.72; manganese, 0.72 to 0.79; silicon, 0.09 to 0.12; phosphorus, 0.03 to 0.06.

increased phosphorus if you could? These specifications seem to imply that you could get rails of open-hearth steel. Would you keep your carbon so low and the phosphorus so high when you could control both the elements?

Mr. Trimble:—I think, when you come to get open-hearth steel, that it will be by special arrangement and price, and probably subject to special specifications. Mr. Webster can give you some information on that point.

Mr. William R. Webster:—The open-hearth steel was put in the original specifications of committee No. 1, so that we would not be criticised in confining ourselves to Bessemer steel alone. We want to say that open-hearth steel is a good steel for rails. The mixture given does not apply to open-hearth. If basic open-hearth is used, the phosphorus will be lower and the carbon run up higher to give the equivalent hardness. It is immaterial whether you leave it out of the specifications now or not. But if you leave it out you may be criticised by indicating that you only want Bessemer steel. If you put it in, the mixture does not apply and the Committee will give you a mixture that would apply to open-hearth steel. The Pennsylvania Railroad has recognized the matter of equivalent hardness by reducing the carbon and the manganese when the phosphorus runs up, so that would be carried to a greater extent where your phosphorus is below 0.07, as in open-hearth steel.

Mr. W. C. Cushing (Pennsylvania Lines):—I would confirm Mr. Torrey's experience in regard to the variation in the height of rails. On the division with which I was connected last year we had precisely that same experience. Upon the inspector of the mill being called in to examine the rails, the statement was made that the rails became mixed in the loading, which, of course, implies that the mill must be very particular about how it loads these rails, in order to have them come right. As we know, the cause of this variation is the wear of the rolls, and the more we cut down the limit on this wear of the rolls, the more expensive it is to the mill to roll the rails. But I am heartily in favor of what Mr. Torrey says, in trying to reduce these limits, instead of keeping them as at present. The rails which I speak of had such very great variations that the riding of the track was very uneven, and the worst of it was that it was not discovered until a whole lot

of the rail had been laid. It increases the wear in the case of a low rail following a high rail, because the jump of the wheel is much greater, resulting in a greater hollowing out at that point, so that it really is a matter of great importance, and what we have heard shows that it is a mistake which the mill does not make infrequently.

Mr. Torrey:—I move that 1-64 be substituted for 1-32 in clause 6 on page 6 of the report.

Mr. Trimble:—The Committee will accept that amendment.\*

Mr. Torrey:—I ask if the Committee think it worth while to say anything in clause 10 which will secure straightened rails, smooth on the head. That stipulation is pretty old, but I think the railroads generally did not get very well straightened rail until some of the engineers and experts on rail questions told the manufacturers how far apart for various sections the anvils should be in the straightening press. I do not know but that most mills now have their anvils farther apart than they used to have them.

Mr. Edwin F. Wendt (Pittsburg & Lake Erie):—I ask what the Committee considers as a reasonable variation in the width of the base of the rail?

Mr. Trimble:—The wear of the roll would determine how much variation there would be.

Mr. Wendt:—I ask the question in view of the general use of tie-plates. We received a large quantity of rails which vary 3-32, and make it necessary to take this into consideration in designing the punch for the tie-plates, and I am endeavoring to get information as to what would be a reasonable variation in the width of the base, as the manufacturer claims the right to a reasonable variation and contends that 3-32 is a reasonable variation. Other members of the Association may have had some experience in the same line.

Mr. Trimble:—Mr. Abbott of the Illinois Steel Company, a member of the Committee, says that they could be kept to 1-16 of an inch and says that would be a reasonable variation in width.

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\*On further investigation, the Committee finds that it would be inadvisable at the present time to insist on the requirements in regard to variations in heights of rail proposed by Mr. Torrey and accepted by the Committee and approved by the Association, namely,  $\frac{1}{4}$ " over and  $\frac{1}{4}$ " under the standard, and recommends that the limits originally submitted by the Committee ( $\frac{3}{16}$ " over and  $\frac{1}{4}$ " under the standard) be substituted.  
—THE BOARD OF DIRECTION.

If that would be satisfactory to the members of the Association we will embody it in the specification.

Mr. Wendt:—At the time the variation was discovered the manufacturers stated that 3-32 was, in their judgment, a reasonable variation; in other words, the manufacturers found in favor of themselves. It was necessary on our part to have 15,000 tie-plates repunched.

Mr. F. E. Abbott (Illinois Steel Company):—Did Mr. Wendt find any variation in the plates or spikes he used?

Mr. Wendt:—As far as the punching of the plates was concerned, that was as nearly perfect as we could expect. I do not know about the spikes.

Mr. Torrey:—I move that the heading, "Chemical Properties," be followed by the words, "For the Bessemer process." That won't do anything with the open-hearth, except that we recognize that we can get open-hearth.

Mr. Trimble:—The Committee will accept that.

Mr. Torrey:—In regard to the last sentence in paragraph 6, I would move that it read: "A perfect conformity of the fishing dimensions, however, shall be maintained at all times."

Mr. Churchill:—It seems to me, when you say the rails shall conform to the American Society section, it should cover all dimensions.

President Kittredge:—You are providing for variations in some particulars, and in other particulars you do not want to admit any variations. I think that is the difference between the first part of the paragraph and the last part.

Mr. Torrey:—The point of that is that the fishing dimensions can be maintained if you make the second set of rolls like the first in that regard. Whereas we have to stand a drop of 1-32 in this extreme limit we allow, it is still desirable not to have any drop between the underside of the head of the rail and the fishplate, if you happen to have two rails adjoining with different fishing dimensions.

Mr. D. W. Lum (Southern Railway):—Many of the railroads now purchase the largest section they use, and, of course, want to lay all the new rail in the main track, and for that reason it would seem to me that the word "seriously" might be left out; that is to say, rails which contain any physical defects which

impair their strength, shall be rejected. It seems to me there might be some question between the manufacturer and the inspector as to what might be considered a "serious" impairment.

Mr. Trimble:—The Committee is willing to omit the word "seriously."

Mr. W. B. Poland (Baltimore & Ohio Southwestern):—The road with which I am connected some time ago purchased a large quantity of rails, and a large part of them were bowed or strained vertically. Apparently they had been straightened out while not entirely cool, and after they had cooled off they had contracted unequally and bowed up as much as half an inch in the length of the rail. The bowing was very slight, but it was noticeable in the track. It seems to me, on page 7, paragraph 10, it might be well to specify how much variation from an absolute straight should be allowed in the straightening of the rail. I would suggest that not more than a quarter of an inch should be allowed in this particular.

Mr. Trimble:—The Committee thinks we ought to have straight rails. We do not care to admit any variation in this respect. We think you had better try to send these rails back and get straight ones.

Mr. Poland:—That is well enough theoretically, but practically there is hardly a rail received which has not a slight camber. What are you going to do? Suppose you get a shipment of rails that are slightly out of true. I do not think that many of our General Managers would want the shipment sent back unless it was shown that the manufacturers failed to comply with the specifications.

Mr. F. E. Abbott:—Were the ends low or high as the result of the camber?

Mr. Poland:—The ends were high. The contraction was in the ball of the rail.

Mr. C. S. Churchill (Norfolk & Western):—That point is covered by the inspector if he does his work right. Our road has had for many years an inspector of rails, and no doubt many of the roads have such an inspector. If the inspector does not turn in good rails, he hears from us. It is the fault of the inspector if he accepts such rails.

Mr. Trimble:—I would answer that question in another way: On account of the thickness of the metal in the base and the metal

being concentrated in the head, there is a different rate of contraction. The new committee of the American Society of Civil Engineers will probably fix this matter up for us, and after they get through we will not have any more trouble in regard to modification of the section.

Mr. Torrey:—I suggest that paragraph 10 be amended to provide that rails shall be finished straight and finished while cold.

Mr. Trimble:—The Committee will accept that amendment, that the rails shall be straight when finished and shall be straightened while cold.

Mr. F. E. Abbott:—In connection with this discussion on straightening of rails, I will say that certain roads have asked for what they call a "back sweep;" in other words, the mills have made an effort to finish the rails with the ends slightly turned up. The expectation is, of course, when the angle bars are applied they will be able to draw the rails to a true surface, and that the spiking will also serve in this direction. Ordinarily a slight back sweep has not been objected to by the roads. The mills, without any instructions, will straighten the rails as much as possible; otherwise they will comply with any special order which is desired.

President Kittredge:—We have in the room Professor Johnson, of the University of Wisconsin, and exercising the privilege granted to the presiding officer, I invite Professor Johnson to speak on this subject.

Prof. J. B. Johnson (University of Wisconsin):—I have no remarks to make. I inquired if I might say a word if I wanted to. Now that I find that I may do so, my mind is entirely at ease, so that if I should wish hereafter to take part in the discussion I should be glad to have the privilege. There are present other college professors, who are entirely disinterested in these questions, except scientifically, and they would doubtless be entitled to the same privilege. I was a member of this committee No. 1 of the International Association, and have had my chance in this individual committee. The chairman of the Committee, instead of speaking of this as an imperfect specification, good until it could be perfected, might have said that it is an incomplete specification, but very good as far as it goes. When you speak of anything as imperfect, we conceive of its having faults and objec-

tions; whereas, if you speak of it as being incomplete, we think of it as being good for the present, but to have something added to it in the future. The specification is excellent and embodies all that could wisely be embodied in a specification at this time; but new matters will come up later and the specification in that respect is incomplete. It is well to make progress in these matters as fast as we can, and not to hesitate to act on them because we do not yet know it all.

Mr. Trimble:—The chairman accepts the correction. "Incomplete" is what we had in view, not "imperfect."

Mr. Webster:—I ask Prof. Johnson if he remembers some figures he submitted in connection with committee No. 1, in regard to what he thought should be the drop test on a 100-pound rail? If I remember correctly, you criticised 19 feet as the fall of the drop, and said that theoretically it should be about 29 or 30 feet, that brought out differences in the quality of the steel in the heavy rail which was finished at a high temperature, as compared with the quality of the steel in a lighter section, which was finished at a low temperature. I want to know if I am correct in these figures, because it has an important bearing on the structure of the heavy rails. If we can get the mills to finish rails cold, we are going to get a better structure.

Prof. Johnson:—I do not remember the figures. I only remember that I had under consideration these relative drops, but it was from a theoretical standpoint. I realize that no theoretical consideration should be accepted until it is proven practically. I hope the Committee will investigate this matter of the relative drops for the different weights to see that they are properly graduated. I do not think these relative weights are properly proportioned to the cross-section. Taking the volume as a measure of resistance to shock, the relative drops as given here are really not properly proportioned. The heavier weights should have much higher drops to give the same abusive action; in other words, to develop the same stress on the upper side or to give the same permanent deflection to the rail in a given blow. I would not allow the theoretical argument, however, to determine a matter of that kind, but would prefer to have actual mechanical tests made for these various weights, and find by investigation the relative heights of the drops that would give the result. It would

seem to me from reading these figures, and the fact that the weights differ by an even five pounds, it is a sort of guess, and I still suspect it was a guess on the part of the Committee.

Mr. Webster:—I think the heights and weights are justified in the tabulated statements in the specifications in use.

Prof. Johnson:—Are not all of these guesses? That is, you have here an average guess and each railroad has its own particular guess?

Mr. Webster:—Yes. But we have not had our last guess. I wanted you to assist in bringing out some information that could be used to advantage, and that is why I asked the first question of you.

Prof. Johnson:—I speak on the subject from the theoretical side, and I think the relative heights given are in error. We ought to make an investigation of this matter, and it was my hope that our own committee of the International Association would have had an opportunity of doing that. I never had the opportunity of meeting with them, and only sent in communications once in a while. You have calculated these tests in a way which, in my opinion, is very unequal, very much easier on the heavy sections than it is on the light sections. The subject ought to be studied and experimented with.

Mr. Trimble:—I think possibly we have covered that. Of course, we had nothing before us to indicate whether they were the exact figures used or not, but we give in our report the information which is available, and we ask our members to adopt these suggestions which we make and to obtain the information suggested in regard to chemical composition and shrinkage and other matters.

Prof. Johnson:—That does not quite meet the point. That simply means that we will ultimately get a lot of miscellaneous information, and from that miscellaneous information we cannot draw a wise conclusion. That is not a scientific way of attacking the problem. This matter should be investigated scientifically at some laboratory, where they are suitably provided with apparatus, and obtain the data there and then base specifications upon it. It must be made the subject of special investigation before anything reliable can be obtained, in my opinion.

Mr. Duncan MacPherson (Canadian Pacific):—I should like to ask if—as a detail of manufacture—it is possible to saw the rails when nearly cold. I had some 100-pound rails to lay which were sawn with the ends of bases at right angles to axis of rails, but the planes of the ends were not vertical, so that when laid with bases close together, the heads were in some cases more than one-eighth inch apart. This was no doubt due to the rails having been sawn when too hot. Cannot they be sawn when practically cool, without adding very much to the expense?

Mr. Webster:—It is not practicable; but in England and other places they sometimes specify that the ends shall be faced. If you should cut them cold you would lose one of the most valuable checks you have in the manufacture of the steel—that is, the shrinkage clause we have proposed. That is an absolute check on the temperature at which the rails are rolled. If they are rolled too hot, you get a large grain. The grains are soft, but the planes of cleavages between the grains are well defined and you get a rail that will not stand a sudden shock. If you insist on the rails being finished cooler you will get a better structure and a better drop test, nearer what Prof. Johnson has suggested. I think the amount of shrinkage is the most important point before us. We are not prepared to recommend the amount of shrinkage which should be called for, but we know that the Pennsylvania Railroad has already obtained good results from it to date, and other roads will do the same.

Mr. MacPherson:—With 100-pound rails, or any others, a variation of  $\frac{1}{8}$  inch between length of base and head of rail is very considerable.

Mr. Webster:—The work can be done. The rails are not faced after inspection. They are faced immediately after being rolled. In this country some of the street car rails are faced to lengths.

Mr. G. B. Woodworth (Chicago, Milwaukee & St. Paul):—There is a variation of 1-32 allowed in the rails which are received on the St. Paul road, which is lived up to. They are sawed hot.

Mr. MacPherson:—Cannot there be some action taken on this clause (10) as to the maximum variation allowable between length of heads and bases?

President Kittredge:—Will you make a motion to that effect, specifying the amount which you think proper?

Mr. MacPherson:—I should like to hear from someone having accurate knowledge of details of manufacture of rails as to what is reasonable. There is no use asking for what is impractical.

Mr. F. E. Abbott:—I should say 1-32 can be followed. As Mr. Woodworth has stated, they are able to get rails on his road meeting that requirement. Ordinarily we do not have any trouble in meeting the ideas of the railroad men. Occasionally there may be a loose saw that may make a bad cutting. It is possible that such rails could get by the inspectors and out on the road, but ordinarily there should not be as much difference as you mention. The test is constantly made with accurate squares, and when anything gets out over 1-32 it is by mistake or oversight.

Mr. MacPherson:—I move that an addition be made to clause 10 that the maximum variation allowable between length of bases and heads of rails be 1-32 of an inch.

Mr. Trimble:—That is accepted by the Committee.

Prof. Johnson:—It seems to me that of the same heat of the average quality of steel, rails should be rolled in these various sections, so that presumably you have the very same material in these different sizes specified. Then let these rails, which presumably are of the same material, be tested for different heights of drop, to obtain the corresponding severity of abuse. That kind of information could not be obtained by simply gathering miscellaneous results, because the material is not the same. It is like any other scientific test; it has to be specially made, and the investigation specially designed and prepared, in order to get anything that will be valuable.

Mr. Webster:—I move that Prof. Johnson's idea be carried out, and that the Association make arrangements to carry out such tests as he referred to.

President Kittredge:—That will come later. There is a motion before the house to accept the report and it is being discussed.

Mr. Torrey:—It is against the rules of the Association to recommend anything patented, but in our specifications we provide for testing the rail by a drop test and applying a check which Mr. Dudley has patented. It is the extension of the lower part

of a rail, and there is some limit which must not be exceeded or must be met.

Mr. Webster:—The percentage of stretch that must be met. That patent you refer to won't hold water. Anyone can use it.

Mr. Torrey:—Is it worth anything?

Mr. Webster:—You get the same thing in deflection; it is another way of reading; that is all.

Mr. Torrey:—I have talked with Mr. Dudley about it, but was afraid to say anything concerning it here, for fear of making a fool of him as well as myself.

(On motion, the report of the Committee was adopted.)

President Kittredge:—The next committee to be heard from is the Committee on Iron and Steel Structures.

## REPORT OF COMMITTEE No XV.—ON IRON AND STEEL STRUCTURES.

*To the Members of the American Railway Engineering and Maintenance-of-Way Association:*

Your Committee on Iron and Steel Structures has attempted to cover only a small part of the subject assigned to it. The Committee is substantially a new one, having been separated from the original Committee on Bridges and Trestles and organized by the Board of Direction in May last. The work is hence in a measure new to it, and the small showing of results must be excused partly on this ground and partly on the ground that the members have their time fully occupied with other duties.

The features of the subject selected for study and the sub-committees assigned to gather information, were as follows:

First—The general practice in placing railroad bridge work under contract: Mr. J. P. Snow, Mr. J. R. Worcester and Mr. William Michel.

Second—Specifications for rolled steel: Mr. T. L. Condron, Professor C. L. Crandall and Mr. J. E. Greiner.

Third—Live loads, impact and unit strains: Mr. B. Douglas, Mr. O. Bates and Mr. R. Modjeski.

The method adopted for handling the work was to have each sub-committee compile all possible information regarding the subject assigned to it and transmit a preliminary report, with reasons for arriving at the conclusions reached, to the chairman; he to make duplicate copies and transmit them to the members of the general Committee for their discussion, criticism, addition or suggested amendment; the members to return their comments to the chairman, and he to send the whole mass, with his suggestions, to the original author for revision in such shape as to be acceptable to the whole Committee, if possible, the revision to be ap-

proved by the whole Committee before being embodied in the final report to the Association. It has been possible to execute a part only of this program.

On subject No. 1 we beg to submit a unanimous report, as follows:

### THE GENERAL PRACTICE IN PLACING RAILROAD BRIDGE WORK UNDER CONTRACT.

This subject has been studied by the Committee for the reason that it is one of the essential preliminaries in the work of building a bridge, and as it is sometimes handled in a manner unsatisfactory to the builder and perhaps to the engineer responsible for the execution of the work, it is thought that a full review of its different phases may be of interest to the Association.

An endeavor has been made to obtain opinions from railroad officials as bridge buyers, from engineers as designers, and from bridge companies as builders, in order to reach the subject from all points of view. Replies have been received from 86 railroads, 14 engineers (not railroad employes) interested in the design of bridges, and 8 builders of structural work. Considerable diversity of practice is apparent from these replies, and, although each one's method appears to be satisfactory to them, it is evident that certain details sometimes employed are objectionable when looked at from a different standpoint.

It is believed that a presentation of the impressions received from our correspondence with the above parties and the conclusions reached through our study and practice may be of use in leading to more uniform methods and in pointing out what is undesirable in the practice of those who may not have given the subject much close thought.

The proper business principles underlying the act of placing a bridge under contract are the same as those applying to the purchase of other commodities. The buyer should be assured of getting what he wants and the seller of getting a fair price for what he furnishes. The business is, ordinarily, however, different in detail from buying most of the appliances needed in the operation and maintenance of a railroad.

A locomotive or machine may be ordered to be identical with one already built, or may be selected from a builder's catalogue, or may be subject to a duty test before acceptance; a building may be altered during construction or after completion if not satisfactory, but none of these possibilities apply to the buying and building of bridges, except in the rather rare case of using standard plans. It is seldom that an exact duplicate of an existing bridge is what is needed to properly fit a given location and set of conditions. It remains, then, that a bridge must generally be fully designed by someone before construction is commenced and a builder chosen by some satisfactory process of selection to execute the work. These considerations indicate the two principal features to be considered, viz.:

First. The degree of completeness of plans and specifications that the railroad should furnish for the purpose of informing the bidders what is wanted.

Second. The best manner for the railroad to select the proper builder to construct its work.

Secondary questions to be considered are:

*A* Shall bids be a lump sum for each job or by the pound?

*B* Shall bids be obtained for each structure or group wanted at one time, or shall contracts be made for whatever may be wanted during the season?

*C* Shall the work be erected by the contractor or by the railroad?

These five points are more or less interdependent and in turn are controlled by other elements of the problem. As railroad administration stands at present some roads have many bridges and some have few. No two are organized on exactly the same lines, and very few are subject to exactly similar conditions. The personality of the officers counts for much in the transaction of a road's business and financial considerations oftentimes outweigh all other factors. Hence it is evident that no hard and fast rule can be laid down for each of our items that will apply to all roads, but that we should aim rather to present satisfactory methods that are broad enough to cover all ordinary conditions and point out the objectionable features in the methods sometimes employed.

*First—As to the degree of completeness of plans and specifications to be furnished by the railroad.*

Under this head there are three distinctive courses open:

*a* Plans of more or less detail, but sufficiently full and precise to allow the bidder to figure the weight correctly and if awarded the contract to at once list the mill orders for material.

*b* General outline drawings showing composition of members, but no details of joints and connections.

*c* A full specification with survey plan only, leaving the bidder to submit a design with his bid.

Of 72 railroads replying definitely to this phase of the inquiry, 24 roads, covering 55,809 miles, make use of course *a*; 13 roads, covering 28,753 miles, use course *b*, and 35, covering 32,683 miles, course *c*. A large majority of the engineers and bridge companies responding favored the making of detail plans.

The engineer of a prominent bridge building company, in his correspondence on this subject, says: "Among the various methods now in vogue, there are two which are satisfactory. One is to furnish complete detail drawings and specifications; the other is to furnish specifications, survey plans and other information, leaving it to the bidder to make his own design. Furnishing a diagram showing composition of members only is not so satisfactory to the bidder, as the strain or section sheet is not a complete design. In order to obtain a close bid, it is essential to furnish such information as will enable the bidder to figure the cost of shop work with reasonable accuracy, which he can do only if either a complete design is furnished to him, or if he is at liberty to follow his own practice as regards details of construction, in which case he should make his own section sheet. To submit a strain or section sheet only without details to

the bidder is not very satisfactory, as it will sometimes require more time and study to work up a good design from the same and at the same time conform to the sections and sizes given therein, than if the bidder would also make the strain sheet to conform to his own practice in the construction of details and connections."

It would seem to be a plain business axiom that the buyer of a bridge should know definitely what he wants before asking for bids, and, in order to enable bidders to make close prices, that he should furnish such drawings and descriptions as will leave no uncertainty as to what he requires either in the structure, the materials or the method of executing the work.

Under course *a* the degree of completeness of the plans must depend largely upon the preferences of the engineer and the time and office facilities available. Complete shop plans are preferred by some; what may be called engineering plans, drawn to a scale sufficiently large, say one inch per foot, to clearly show the arrangement of all connections, packing of pins, number of rivets, thickness and shape of all fillers, division of shop and field rivets, make-up and size of all shoes and bearings, and, in fact, how all parts of the bridge come together and how they are fastened together, but not complete enough for ordinary shop drawings, are preferred by others; while still others make small scale drawings only, showing no rivets, but covering the plan with notes and directions sufficient to guide the bidder to a fairly complete understanding of all details.

If the plans are complete enough for listing the mill orders, which must be considered the minimum requirement covered by this course, they will show the bidder clearly what the character of the shop work will be and enable him to compute the weight with precision. With this minimum in view any degree of elaboration may be indulged in that the engineer deems advisable.

If a large quantity of work is wanted when it seems probable that prices will advance, it may be advisable to get it under contract at once before drawings can be made. In this case a description of the work wanted, with approximate weights, accompanied if possible by detail plans of similar bridges, may be sent to bidders and prices obtained per pound; detail plans to be made later by the railroad or contractor as may be agreed upon.

If a single bridge must be obtained in the shortest possible time, it is probable that the best way to proceed is to invite proposals per pound, as above described, and, while waiting for bids, to prepare plans sufficiently full for ordering the stock, these plans to be turned over to the contractor when the award is made, the material ordered by him and the shop plans and patterns made while the stock is being rolled. These methods require that a competent engineer be employed by the railroad to prepare the plans. He may be a regular employé or an outside party temporarily engaged as consulting engineer.

If course *b* is followed, the contractor generally works up the details subject to the approval of the railroad officials. The opinion of the engineer quoted above states the objection to this course from the con-

tractor's point of view. His position will be appreciated by all engineers who have had competitive plans submitted to them for comparison and recommendation. All such know how unsatisfactory the task is; how much more agreeable it is to make a complete design from the start than to patch up and alter something imperfectly worked out and perhaps badly conceived. Why, then, should bidders be asked to take half-worked-out schemes and complete them?

It may be claimed that this course consumes less time than *a*. This is true so far as placing the contract is concerned, but the proper objective is the completion of the bridge, and this can be reached quicker by course *a* than by course *b*. Other things being equal, the deciding feature is *ordering the stock from the mill*; and by far the quickest time can be made between the decision of the railroad to build and the placing of mill orders if the railroad makes scale plans of the work. If the contractor must work out plans before he can order his stock, they must be finished up, sent to the railroad and be examined and criticised and perhaps sent back and forth several times before they are safe to be used for listing material.

It seems that course *b* has but little to recommend it. Economy in the drafting room of the railroad is about all that can be claimed in its favor, and in this feature it is surpassed by *c*, which can be modified so as to be entirely satisfactory.

As written above, course *c* consists of furnishing "a full specification only, leaving the bidder to submit a design with his bid." The assumed advantages of this course are its apparent economy to the railroad and the benefit of competitive designs from a number of bridge builders. If we modify the clause so as to read "a full specification only" and ask for bids by the pound and require no accompanying design, it will be wholly satisfactory. Asking bidders to submit plans with their tenders leads to practical difficulties of several kinds. On this point the engineer previously quoted says: "I beg to call your attention to the prevailing practice of railroad companies requiring to have strain sheets and designs submitted with bids. The demoralizing influences of this practice of requiring bridge companies to make designs on speculation does not seem to be sufficiently appreciated by railroad engineers, they believing the bridge companies do this work gratuitously and at no expense to the railroad company. However, a moment's reflection will prove the fallacy of this assumption. Each bridge company employs a number of engineers, a large portion of whose time is taken up in making strain sheets and estimates to accompany bids, a small portion of which only develop into contracts, the work being either let to other companies or is not let at all at the time. Suppose five bridge companies are invited to bid a lump sum on a piece of work and are required to submit strain sheets, etc., with their bids, in which case five men are all doing the same work, or, in other words, the same piece of work is done five times and four men's work and energies are wasted. All this superfluous work has to be paid for by the bridge companies, and increases the expense of their engineering departments, and will, there-

fore be charged to the cost of the work. Every well-regulated bridge company includes the cost of this work in their estimates of cost, charging a higher price for lump sum jobs for which strain sheets and designs have to be submitted with the bid than for jobs on which a pound price only is required, and which puts the bridge company practically to no expense in making a bid.

"What the writer in his capacity as head of the engineering department of a bridge company mostly objects to is the demoralizing influence this practice of making designs on speculation has on his subordinates, whose duty it is to make strain sheets and designs. It is certainly discouraging to an engineer who is conscientious and takes pride in his work to know that over three-fourths of his work is thrown away, and less than one-fourth only is actually going to be constructed. It has a tendency to make these men careless and superficial, as it can hardly be expected that a man will take the same interest in a speculative and problematical design as in a design for an actual piece of work, more particularly as he is not allowed enough of time to do this kind of work thoroughly. He will, therefore, rush the work without giving it that careful consideration which he would give to an actual piece of work. The writer has had many times occasion to revise a design which was submitted with a bid and accepted by the railroad company, but which did not meet his own idea of good practice."

This is from the standpoint of a contractor, but all must admit the force of the argument. As may be seen above, nearly half of the railroads responding to our inquiries use this objectionable method of obtaining bids, but it will be noticed that the mileage of these roads averages considerably less than half that of the other two groups.

As to the two assumed advantages for this course, economy in the railroad drafting room will be served quite as well if the bidders do not submit plans as if they do; and the benefit of competitive designs is largely fallacious. A prominent bridge specialist writes us in his response: "I am well aware that the marvelous development of American bridge building has been largely due in the past to the method of competitive designs from contractors, but that stage of evolution has now worked out its full mission and established the design and manufacture of bridges on sound scientific principles."

A given railroad should have some uniformity in the type of its bridges, and certainly competition in design will not conduce to this result; neither will it enhance excellence of detail; and extreme economy of material is no longer desired. It would seem that obtaining competitive plans from bidders should be discouraged by the Association, unless it be in extraordinary cases of suspension, cantilever, or arch bridges, which are not within the scope of this report.

Unless a railroad leaves the whole matter with the contractor (which is unwise), a competent and experienced bridge engineer should be employed to check the design and superintend the inspection. If this is done, the single design furnished by the successful bidder after the award of

the contract will be under as full control by the railroad as in the case when sketch designs are submitted with all the bids.

These views are presented thus at length with the hope that members of the Association can be brought to see the undesirability of furnishing bidders with partially worked out designs, expecting the contractor to complete them, and more particularly the serious objections to requiring bidders to furnish designs with their bids.

*Second—The best way to select the proper builder.*

The advantages of competition are so well recognized that no arguments need to be presented in its support. As to whether competition should be obtained by advertising or by selecting a few suitable bidders, the advantages, for railroad work, are all on the side of the latter method.

An engineer can serve his employers in no better way than in selecting a proper list of bidders for each class of work. If desirable, he can encourage small local concerns by giving them a chance to bid on small work, and he can omit them from the list on difficult work. If acquainted with the condition of the shops of different builders, he can judge if they are fitted for special classes of work and can turn it out in a reasonable time, and can make up his list of bidders accordingly.

A fair price can be obtained ordinarily by getting tenders from not over six bidders. Only those who would be acceptable as contractors should be asked to bid, and then the work should be let to the lowest bidders without further canvass.

*A—Shall bids be a lump sum for each job or by the pound?*

The great majority of the responses to our inquiries on the subject favor letting bridge work by the pound. This method satisfies the business principle that the seller should be paid for exactly what he furnishes. It relieves the estimator from much responsibility when working up the weight of a bridge for the purpose of making a bid, and thereby reduces the cost of this operation. It allows changes to be made in a design without hardship to anyone, and it is the only proper basis for bids when a specification only is furnished, while it is also applicable to the case when full plans are furnished.

On the other hand, a lump sum bid allows the buyer to know exactly what a given job will cost, and obviates disputes, which sometimes occur when a pound price is used, as to the final and complete weight when the bills are rendered. When the work is varied, like a draw-bridge, it is undoubtedly the best method of fixing a price. It involves no hardship to the bidder when the railroad furnishes full plans, but is not applicable to those cases where a specification only is furnished. In short, it is a business question to be decided largely by the convenience of the purchaser, governed by the limitation of the course pursued in obtaining bids.

The shipping weights of all parts of a bridge should be closely checked with the plans by the engineer in any case to detect underweight if the contract is by the lump, and to guard against excess weight if by the pound.

*B—Shall bids be obtained for each structure as wanted, or shall contracts be made for whatever may be wanted during a season?*

If a season's requirements can be anticipated with sufficient certainty so that reasonable descriptions can be furnished to bidders, it is good business policy to make a contract cover the whole, for the reason that a large tonnage of work is very attractive to bridge companies and will call out lower prices than if cut up into smaller lots at different times. Good judgment, however, is needed as to the proper time to let the work. There is an undesirable element of speculation involved unless the price per pound is made adjustable to the market price of material at the time each bridge is detailed, and if this is done the result is practically the same as letting each bridge separately. Blanket contracts do not give a railroad opportunity to patronize small local shops, which for business reasons may be advisable, and for those roads which erect part of their work, but not all, the separation of the two classes might be awkward.

Nearly all the railroads replying to our questions usually make independent contracts for each bridge or group of bridges that can be let at one time, and under ordinary circumstances this would seem to be the proper course.

*C—Shall the work be erected by the contractor or the railroad?*

This question is one of economy largely, and will depend on the organization and custom of each road. When equipped for it and there is sufficient work to be continuous, railroad forces can erect ordinary bridges cheaper than can be done by contractors. If work is intermittent, it will be expensive for railroad men to do it, for the reason that unprofitable work will be done in an attempt to keep the gang together between jobs.

Repair work, however extensive, should ordinarily be done by the railroad, and single girder bridges can generally be put in much cheaper by the resident force than by men from a distance; with larger structures the case will differ on different roads.

Fifty-seven of the 86 roads replying to our circular state that they contract for the whole or part of their work erected, though 59 of the 86 erect at least the smaller bridges, and experience shows that when properly controlled and managed erection work can be done by contractors' forces with safety and with no undue delay to traffic. On the other hand, with proper organization and equipment, it is economical and eminently satisfactory to all parties to do the work with railroad forces.

In conclusion, the Committee suggest the following recommendations for the consideration of the Association:

First. That it is preferable for railroads to furnish detail plans of bridge work to bidders complete enough, at least, for a precise determination of the weight of the structure and for listing the mill orders by the successful bidder. If such drawings cannot be furnished, the alternative should preferably be full specifications, giving directions for the detail design of the structure, accompanied by a survey plan and all needed information concerning the work; the bids in this case to be by the pound and not accompanied by a design, the detail plans to be made later by the railroad or contractor, as may be understood.

Second. To invite a few parties (not always the same) to submit bids for the work.

Third. When detail plans are furnished, to ask for a lump sum bid or a pound price, as may be preferred by the purchaser; but when a specification only is furnished, to invariably ask for a pound price.

Fourth. To award contracts for as large groups of bridges as can be fully defined consistently with recommendation No. 1, and when required by circumstances to anticipate future requirements if necessary to protect the interests of the railroad.

Fifth. That the question of erecting the work by railroad forces or by contract should depend upon the custom, organization and equipment of each railroad concerned.

### SPECIFICATIONS FOR ROLLED STEEL.

On subject No. 2, Specifications for Rolled Steel, your Committee has done an unusual amount of work, but has been unable to agree on a complete recommendation to the Association. It is thought best to present a progress report, only stating the points on which there is substantial agreement, as well as the points on which there is a difference of opinion, with the understanding that the report is subject to probable revision after further discussion.

The points on which there is no serious disagreement are the following. It will be seen that they cover nearly complete specifications, with the exception of the grade of steel to be provided for, which is the subject of the discussion further on:

#### *Process of Manufacture.*

1. Steel shall be made by the open-hearth process.

#### *Sample for Chemical Analysis.*

2. In order to determine if the material conforms to the chemical limitations prescribed below, analysis shall be made of drillings taken from a small test ingot. When required by the inspector, check analyses shall be made of drillings from the finished product.

#### *Chemical Requirements.*

Rivet steel: Sulphur and phosphorus each not over 0.04 per cent.

Steel for other uses. Sulphur not over 0.05 per cent.

Phosphorus in basic steel, not over 0.04 per cent, and in acid steel not over 0.08 per cent.

#### *\*Physical Requirements.*

4. Rivet steel: Tensile strength between 48,000 and 56,000, minimum yield point 26,000, minimum elongation 28 per cent, bending test 180 degrees flat without fracture, whether hot or cold. (See 9.)

#### *Fractures.*

5. All fractures shall be silky. A dull or crystalline fracture will be considered a failure of test, and a retest required. (See 19.)

\*For physical requirements for other grades than rivet steel, see page 232.

*Yield Point.*

6. For the purpose of this specification, the yield point shall be determined by the careful observation of the drop of the beam or halt in the gauge of the testing machine.

*Modification in Elongation for Thin and Thick Material.*

7. For each increase of one-eighth inch ( $\frac{1}{8}$ " ) in thickness above three-quarters inch ( $\frac{3}{4}$ " ), a deduction of one per cent (1%) shall be allowed from the specified elongation, and for each decrease of one-sixteenth inch ( $\frac{1}{16}$ " ) in thickness below five-sixteenths inch ( $\frac{5}{16}$ " ), a deduction of two and one-half per cent ( $2\frac{1}{2}$ %) shall be allowed from the specification.

*Pin Steel.*

8. In steel for pins the elongation required shall be five per cent (5%) less than that specified, as determined on a test specimen cut from the finished rolled or forged bar from which pins are to be turned, the center of which specimen shall be one inch (1") from the surface of the bar.

*Nicked Test.*

9. Rivet steel, when nicked and bent 180° around a bar, equal in diameter to the rivet rod, shall show a gradual break and a fine silky fracture. A sudden crystalline fracture will be considered a failure of test and a retest required. (See 19.)

10. For material other than rivet stock, more than 1 inch thick, bending tests may be made on specimens from the same melts of steel, but of less thickness. In such cases, the thickness of the bending test specimen shall be not less than 1 inch and may be planed or turned to this thickness.

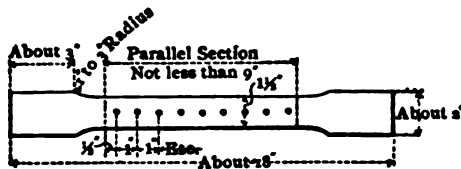
*Special Tests for Steel.*

11. Steel shall also be subjected to the following test: (a) A fifteenth-sixteenth-inch hole punched with center  $1\frac{1}{8}$  inches from edge of sheared plate must stand drifting, without cracking the metal, until diameter of hole becomes  $1\frac{1}{4}$  inches.

(b) Angles  $\frac{3}{4}$  inch and less in thickness shall open flat, and all angles  $\frac{1}{2}$  inch and less in thickness shall bend shut, cold, under blow of a hammer, without sign of fracture.

*Test Specimen for Tensile Tests.*

12. The standard test specimen of eight-inch (8") gauged length shall be used to determine physical properties. The standard shape of the test specimen for sheared plates shall be as shown by the following sketch:



13. For other material the test specimen may be the same as for sheared plates, or it may be planed or turned parallel throughout its entire length, and in all cases, where possible, two opposite sides of the test specimen shall be the rolled surfaces. Rivet rounds and small rolled bars shall be tested of full size as rolled.

*Test Specimens for Bending Test.*

14. The test specimens for bending tests may be the same as for tensile tests, except as called for in paragraph No. 11. They shall preferably be one and a half inches ( $1\frac{1}{2}$ " ) wide. Rivet rounds and small rolled bars to be tested full size as rolled.

15. The bending test may be made by pressure or by blows.

*Number of Tests.*

16. At least one tensile and one bending test shall be made for each "variety" of material into which a melt of steel is rolled under these specifications. Each of the following shall constitute a "variety:" (1) Angles and Z-bars; (2) I-beams and channels; (3) Universal plates; (4) Sheared plates; (5) Bars and rounds. Steel differing in thickness more than 25 per cent from that tested shall require separate tests.

*Failure of Tests.*

17. If the ultimate tensile strength or yield point of any one test is 1,000 or more pounds per square inch outside of the limits of these specifications, the lot of steel from which such test was taken shall be rejected without further testing, unless there is manifest flaw in the test specimen.

*Retests.*

18. If the ultimate tensile strength or yield point of any one test is below or above the prescribed limits of these specifications, by less than 1,000 pounds per square inch, two other tests may be made from the same lot of steel represented by such test. If these two last tests are within the limits of the specification the lot of steel will be accepted, otherwise it will be rejected.

19. A retest may also be made if the elongation or character of fracture of the tensile test specimen or the bending test is not in accordance with the requirements. In case of the failure of the retest, the lot of steel will be rejected.

*Annealed Test Specimen.*

20. Material which is to be used without annealing or further treatment shall be tested for tensile strength in the condition in which it comes from the rolls. For material which is to be annealed or otherwise treated before use, a full-sized section of tensile test specimen length shall be similarly treated before cutting the tensile test specimen therefrom.


*Finish.*

21. Finished material must be free from injurious seams, flaws or cracks, and have a workmanlike finish.

*Branding.*

22. Every piece of steel shall be stamped with the name of the manufacturer or mill at which it is made and the melt number and year; also the class of steel. Steel for pins and forgings shall be stamped on the ends. Rivet lacing bars and small pieces for pin plates and stiffeners may be shipped in bundles, securely wired together, with the stamps on a metal tag attached.

23. Each piece of steel furnished under these specifications (except rivet rods and other small rolled bars) shall, before shipment, have branded cold upon it, by the manufacturer, this mark, **AR** in letters two inches high, by which the manufacturer shall denote that the material so branded

has been tested by him in full accordance with the requirement of these specifications, and has successfully withstood all of the tests herein provided for, and is of such quality as is hereby required. In case any piece of steel, after having been so branded, is condemned, for any cause whatsoever, then the brand shall be defaced by a ring stamp, thus 

#### INSPECTION.

##### *Duties of Inspector.*

24. The inspector representing the purchaser shall be afforded all necessary facilities by the manufacturer to satisfy him that the material is being made and furnished in accordance with the requirements of the specifications. It shall be his duty to see that the system of tracing the steel from the melt to the finished product is adequate and reliable. He shall witness all tension tests and keep a personal record of the same, and shall, so far as practicable, satisfy himself that all tests are carried out in a bona fide manner. In cases of failure of tensile or bending tests he shall require satisfactory evidence that the material condemned thereby is not, through negligence or for other reasons, shipped on contracts governed by these specifications.

##### *Rolling Orders.*

25. The manufacturer shall furnish the inspector, daily, if required, a correct list of all the steel rolled, on orders subject to his inspection, from every melt as rolled, indicating on this list from what pieces tests have been or will be prepared. The inspector shall satisfy himself that sufficient tests have been provided for, and after the tests have been made, he shall notify the manufacturer what material has been successfully tested and what, if any, has failed upon tests.

##### *Certified Shipping Bills.*

26. The manufacturer shall also furnish the inspector duplicate copies of the shipping bills or detailed lists, giving melt numbers of the material loaded for shipment on orders subject to his inspection, and after the inspector has checked these with his records of tests and accepted material, he shall sign both copies and return one copy to the manufacturer and shall send the other copy to the railroad company he represents. If these shipping bills do not check with the inspector's records of tests and accepted material, he shall not sign them, and the shipment shall not go forward until the difference is rectified.

27. No material shall be paid for by the railroad company until the bill of shipment is checked and approved by the inspector.

##### *Surface Inspection.*

28. The inspector shall have the right to make a surface inspection of any and all material under these specifications, and, when he so elects, the necessary facilities shall be afforded to him by the manufacturer. Whether the inspector makes a surface inspection of the material at the mill or not, no material having any injurious flaws will knowingly be allowed to become a part of any bridge or other structure, and in case of the discovery of any defective material shipped from the mills it will be condemned at bridge site, and will not be paid for, and it will have to be replaced by the manufacturer without additional expense to the railroad company for material, workmanship, or other charges.

## ALLOWABLE VARIATION IN WEIGHT.

*Variation in Weight.*

29. The variation in cross-section or weight of each piece of steel of more than  $2\frac{1}{2}$  per cent from that specified will be sufficient cause for rejection, except in the case of sheared plates, which will be covered by the following permissible variations, which are to apply to single plates:

30. Plates twelve and one-half pounds per square foot or heavier, when ordered to weight, shall not vary more than  $2\frac{1}{2}$  per cent above or  $2\frac{1}{2}$  per cent below the theoretical weight.

31. Plates under twelve and one-half pounds per square foot, when ordered to weight, shall not vary more than the following:

32. Up to 75 inches wide,  $2\frac{1}{2}$  per cent above or  $2\frac{1}{2}$  per cent below the theoretical weight.

33. Seventy-five inches and over, 5 per cent above or 5 per cent below the theoretical weight.

34. For all plates ordered to gauge, there will be permitted an excess of weight over that corresponding to the dimensions on the order equal in amount to that specified in the following table:

TABLE FOR ALLOWANCES FOR OVERWEIGHT FOR RECTANGULAR PLATES WHEN ORDERED TO GAUGE.

35. The weight of one cubic inch of rolled steel is assumed to be 0.2833 pound. Plate one-fourth inch and over in thickness.

Thickness of Plate. Inch.	Width of Plate.		
	Up to 75 Inches. Per Cent.	75 to 100 Inches. Per Cent.	Over 100 Inches. Per Cent.
$\frac{1}{4}$	10	14	18
$\frac{5}{16}$	8	12	16
$\frac{3}{8}$	7	10	13
$\frac{7}{16}$	6	8	10
$\frac{1}{2}$	5	7	9
$\frac{9}{16}$	$4\frac{1}{2}$	$6\frac{1}{2}$	$8\frac{1}{2}$
$\frac{5}{8}$	4	6	8
$\frac{3}{4}$	$3\frac{1}{2}$	5	$6\frac{1}{2}$

Plates Under  $\frac{1}{4}$  In. Thickness.

Thickness of Plate. Inch.	Width of Plate.	
	Up to 50 Inches. Per cent.	50 Inches and Above. Per cent.
$\frac{1}{8}$ up to $\frac{1}{4}$	10	15
$\frac{1}{4}$ up to $\frac{3}{8}$	$8\frac{1}{2}$	$12\frac{1}{2}$
$\frac{3}{8}$ up to $\frac{1}{2}$	7	10

It is probable that exceptions would be taken to many of the items above, provided sufficient time could be had for discussion.

The points on which there is a difference of opinion among the Committee are:

*\*Physical Requirements.*

A. The range of ultimate strength and the factors depending upon it.

B. As to whether the requirements for yield point and elongation shall be fixed limits or ratios of the ultimate strength.

C. As to prescribing a minimum reduction of area.

(See diagram, Fig. 1, page 233.)

\*See paragraph 4, page 228.

Pounds per Square Inch	Manufacturer Standard	Am. Ry. Eng. & Maintenance of Way Assn. Recommended in Report of Committee 1901	Recommendations in Report of Committee 1902 For A & B Grades For T-Bonds	Pounds per Square Inch
70000				70000
68000		Not used	Not used	68000
66000	Medium	Medium	Medium	66000
64000				64000
62000		Not used	Not used	62000
60000	Soft	Soft	Soft	60000
58000				58000
56000		Soft	Soft	56000
54000				54000
52000		Not used	Not used	52000
50000				50000
36000				36000
34000	Medium & Ult. Strength	For Med. 50% Min. Ult. For Soft - 80% of Min. Ult.	For Med. 50% Min. Ult. For Soft - 80% of Min. Ult.	34000
32000		Not used	Not used	32000
30000	Soft & Ult. Strength			30000
28000		Not used	For Soft - 80% of Min. Ult.	28000
26000			Not used	26000
25%	Med. Soft	Med. Soft	Med. Soft	25%
22%				22%
Max. Phos.	.08% .08 Acid or Base	.06 Acid .04 Basic	.08 Acid .04 Basic	.08 Acid .08 Base
Max. Sul.	.05%	.05	.05	.05%

FIG. 1.

A summary of the arguments advanced is here attempted with the hope that the members of the Association will discuss the matter fully so that succeeding Committees on this subject may have the advantage of the information so obtained.

A. On the important subject of range of ultimate strength for framing materials two radically different schemes have been put forward, viz.: First—A single grade to be called structural steel with ultimate strength between 55,000 and 65,000 pounds, one member preferring 57,000 to 66,000.

Second—Two grades, soft steel and medium steel, the former to be between 51,000 and 59,000, and the latter between 61,000 and 69,000.

The advocates of the single-grade scheme claim that the range proposed covers the most desirable class of steel for ordinary structures, built by common shop methods; that it is safe to use without reaming and planing, if so desired, but is improved by reaming and planing to the same extent that harder metal is; and that if the two-grade scheme is adopted with a zone of difference between, the harder grade will necessitate reaming and planing under all circumstances and the softer grade will be unnecessarily low for any purpose; while the most desirable steel (i. e., 60,000 pounds ult.), which is the average of the single-grade scheme and presumably the most desirable, will be shunned as much as possible by manufacturers on account of its being barred out of either grade. In other words, if the proposed two-grade scheme is adopted and manufacturers conform their practice to it that it will be difficult to obtain the grade of steel which they consider most desirable.

The grade of steel recommended at the last meeting of the European Railway Congress for the class of work here considered has a mean ultimate strength of about 57,000 pounds per inch.

For very large structures, where the dead load is a controlling factor in the design, a special grade of material is necessary, which cannot be provided for in a uniform specification, as it might require not only a difference in ultimate strength, but also in various other properties.

On the other hand, the advocates of the two-grade scheme contend that it is difficult to get material as hard as is desirable to use with reaming and planing, unless a zone of difference is introduced, which unavoidably carries the soft grade into quite low steel.

They state that there is no reason from the user's point of view for the two grades merging into each other as now obtains in most specifications. That when so merging together the manufacturers endeavor to reduce their melts to a point where the ultimate strength will be as near as possible on the division line between the two grades, with the result that the product is neither especially soft nor especially strong. That the manufacturers in endeavoring to make this "common ground" steel cover both grades force inspectors to continually test material a little too hard for soft steel or a little too soft for medium steel requirements and that if two distinct grades with a zone of difference between is

established by the Association it will tend to induce manufacturers to develop two classes and will do a great deal towards eliminating the trouble that now confronts engineers and inspectors in obtaining the grade of steel required, and believing that steel of 68,000 or 70,000 pounds ultimate strength may be safely used when reamed, they are unwilling to join in recommending 65,000 pounds as the maximum upper limit.

On this question the Committee stands four in favor of the single grade and five in favor of the two-grade scheme.

A schedule is appended containing replies to a circular issued by the Secretary of the Association from seventeen railroads, seven steel manufacturers, seven officers of universities giving engineering education, and nine consulting engineers. This schedule shows the practice and preferences of those replying as to chemical requirements and ultimate tensile strength.

B. On the question of fixed or variable limits for yield point and elongation the Committee is divided. It is rational to make both of these factors ratios of the ultimate. The object in adopting fixed limits is to facilitate checking inspection reports, but it would seem that with properly prepared tables the labor involved by using ratios would not be more than the advantage gained would warrant. One-half the ultimate is a very common requirement for yield point, but 55 per cent is desired by some, and is no hardship to manufacturers.

If a fixed minimum is specified for elongation it must be a figure that is reasonable for the upper limit of the grade and will be practically no guide at all near the lower limit. A table prepared on a sliding scale for each 2,500 pounds variation of ultimate strength would be very compact and sufficiently precise for practical purposes.

C. As to the reduction of area: This requirement is not generally included in recent specifications. It is undoubtedly a measure of the ductility of the metal, but shows this property only after the elastic limit has been long passed and, as expressed by one engineer, simply shows what the metal does in its last gasp. The majority of the Committee are in favor of omitting it.

### LIVE LOAD, IMPACT AND UNIT STRAINS.

On subject No. 3 the Committee has nothing ready to submit to the Association.

It is to be regretted that we cannot present more of value to the Association. Our members are busy men, and there has not been sufficient time since the organization of the Committee to properly discuss the important features brought forward by our study of the subject. It is thought to be better to lay the matter before the Association in an incomplete state as above rather than to recommend a line of action that quite likely would need radical change before another annual meeting.

In conclusion, the thanks of the Committee are tendered to all those, whether members of the Association or other parties, who have favored us so freely with replies, often at considerable length, to our letters and circulars of inquiry.

Respectfully submitted,

J. P. SNOW, Boston & Maine R. R., Boston, *Chairman*;  
B. DOUGLAS, Mich. Cen. R. R., Detroit, *Vice-Chairman*;  
J. E. GREINER, Baltimore & Ohio R. R., Baltimore, Md.;  
J. R. WORCESTER, Con. Eng., Boston, Mass.;  
T. L. CONDRON, Con. Eng., Chicago;  
R. MODJESKI, Con. Eng., Chicago;  
ONWARD BATES, Con. Eng., Chicago;  
C. L. CRANDALL, Cornell Univ., Ithaca, N. Y.;  
WM. MICHEL, Hocking Valley, Columbus, O.

*Committee.*

Mr. B. Douglas (Michigan Central):—The Committee has done considerable work on the question of the best method of letting contracts, etc., and has come to some definite conclusions to be recommended to the Association. On the question of live loads, impact, unit stresses, considerable work has been done, and a good deal of data collected, but that is hardly in shape to make it worth while for the Association to take up its time in discussing it, and it has not been presented. On the matter of specifications for rolled steel, a good deal of work has been done, and the larger part of the specifications has been drawn up and is acceptable to the Committee. This is given on pages 9 to 13 of the report. On the question of the best grade of steel to be adopted, however, the Committee is very radically divided. Five members are inclined to prefer two grades of steel, one averaging 55,000 pounds, to be used without reaming, and another of the average strength of 65,000 pounds, which is to be reamed. The range of ultimate strength is 4,000 pounds above and below the mean, which leaves an intermediate zone of 2,000 pounds, 59,000 to 61,000 pounds, which would not be accepted in either class, forcing the manufacturers to make two grades of steel instead of doing as they now do, make one grade and call part of it soft and part of it medium.

Now, the recommendations given we would like to have acted on by the Association. The specifications are hardly complete enough, although we would be very glad indeed to have a discussion by members of the Association.

**TABULATION OF 40 REPLIES TO CIRCULAR LETTER "A." SHOWING PREFERENCES EXPRESSED.**  
 Accompanying Report of Sub-Committee on Specifications, A. R. E. & M. of W. Assn.

RAILROADS.	ENGINEERS.	TITLES.	PHOSPHORUM.				SULPHUR.		RANGE OF TENSILE STRENGTH IN THOUSANDS OF LBS.					
			Basic.		Acid.		Ba. or Ac.		Rivet Steel.	Soft Steel.	Medium Steel.			
			.04	.05	.06	.07	.08	.09						
1 H & O R. R.	J. E. Greiner.	Engt. R. & H.	.04	.05	.06	.07	.08	.09	50-60	48-58	52-62	52-60	60-70	60-68
2 H & O R. R.	J. P. Snow.	Bridge Engt.	.	.	.	.	.	.	.	48-58	.	.	.	55-65
3 C. & O. R. R.	F. W. Scarborough	Engt. H. & S.	.	.	.	.	.	.	.	.	.	.	.	.
4 C. & O. R. R.	E. J. Blake.	Chief Engt.	.	.	.	.	.	.	.	.	.	.	.	.
5 C. & O. R. R.	G. W. Kirtland.	Chief Engt.	.	.	.	.	.	.	.	.	.	.	.	.
6 Ill. Cen. R. R.	H. W. Perkins.	Engt. H. & H.	.	.	.	.	.	.	.	.	.	.	.	.
7 Ill. Cen. R. R.	H. G. Kirtland.	Chief Engt.	.	.	.	.	.	.	.	.	.	.	.	.
8 Lehigh Valley R. R.	Walter G. Hart.	Chief Engt.	.	.	.	.	.	.	.	.	.	.	.	.
9 Mich. Cen. R. R.	Robert McDonald	Chief Engt.	.	.	.	.	.	.	.	.	.	.	.	.
10 N. Y. & S. I. R. R.	Wm. W. Le.	Chief Engt.	.	.	.	.	.	.	.	.	.	.	.	.
11 N. Y. & S. I. R. R.	C. S. Churchill.	Chief Engt.	.	.	.	.	.	.	.	.	.	.	.	.
12 N. Y. & S. I. R. R.	H. Kreuzpointner	Engt. M. of W.	.	.	.	.	.	.	.	.	.	.	.	.
13 Penna. Lines R. R.	Thos. Todd.	Chief Engt.	.	.	.	.	.	.	.	.	.	.	.	.
14 Penna. Lines R. R.	Robt. Job.	Chemist.	.	.	.	.	.	.	.	.	.	.	.	.
15 Phila. & Reading R. R.	D. W. Lamm.	Engt. H. & H.	.	.	.	.	.	.	.	.	.	.	.	.
16 Southern R. R.	R. B. Tweedy.	Chief Engt.	.	.	.	.	.	.	.	.	.	.	.	.
17 W. Va. Central Lines.	.	.	.	.	.	.	.	.	.	.	.	.	.	.
<b>STEEL MANUFACTURERS.</b>														
1 Bethlehem.	Reported by Albert Ladd Colby.	Mfg. Engt.	.04	.05	.06	.07	.08	.09	50-60	48-58	52-62	52-60	60-70	60-68
2 Cambria.	Geo. E. Thackeray.	Struct. Engt.	.	.	.	.	.	.	.	.	.	.	.	.
3 Carnegie.	J. W. Anderson.	Genl. Supt.	.	.	.	.	.	.	.	.	.	.	.	.
4 Carnegie.	A. Monell.	Engt. of Tests	.	.	.	.	.	.	.	.	.	.	.	.
5 Bethlehem.	F. E. Abbott.	Inspr. Engt.	.	.	.	.	.	.	.	.	.	.	.	.
6 Peneoyd.	James Christie.	Ch. Mch. Engt.	.	.	.	.	.	.	.	.	.	.	.	.
7 Pennsylvania.	H. H. Campbell.	Gen. Manager.	.	.	.	.	.	.	.	.	.	.	.	.
<b>UNIVERSITIES.</b>														
1 Columbia.	Henry M. Howe.	Prof. Metallurgy.	.04	.05	.06	.07	.08	.09	50-60	48-58	52-62	52-60	60-70	60-68
2 Cornell.	G. L. Crandall.	Prof. R. R. Engt.	.	.	.	.	.	.	.	.	.	.	.	.
3 Cornell.	R. H. Thurston.	Dir. Sibley Col.	.	.	.	.	.	.	.	.	.	.	.	.
4 Lehigh.	Mansfield Merriman	Prof. C. E.	.	.	.	.	.	.	.	.	.	.	.	.
5 Mass. Inst. Tech.	G. F. Swain.	Prof. C. E.	.	.	.	.	.	.	.	.	.	.	.	.
6 Purdue.	W. F. M. Goss.	Dean Scien. Sch.	.	.	.	.	.	.	.	.	.	.	.	.
7 Purdue.	W. D. Pence.	Prof. C. E.	.	.	.	.	.	.	.	.	.	.	.	.
<b>CONSULTING ENGINEERS.</b>														
1 A. L. Colby.	.	Philadelphia.	.04	.05	.06	.07	.08	.09	50-60	48-58	52-62	52-60	60-70	60-68
2 T. L. Condon.	.	Chicago.	.	.	.	.	.	.	.	.	.	.	.	.
3 R. W. Hunt & Co.	.	Chicago.	.	.	.	.	.	.	.	.	.	.	.	.
4 Albert Hughes.	.	Chicago.	.	.	.	.	.	.	.	.	.	.	.	.
5 Albert Hughes.	.	New York.	.	.	.	.	.	.	.	.	.	.	.	.
6 Ralph Modjeski.	.	Chicago.	.	.	.	.	.	.	.	.	.	.	.	.
7 Richard Moldenke.	.	Pittsburg.	.	.	.	.	.	.	.	.	.	.	.	.
8 Osborn Company.	.	Pittsburg.	.	.	.	.	.	.	.	.	.	.	.	.
9 Pittsburg Testing Laboratory.	.	Cleveland.	.	.	.	.	.	.	.	.	.	.	.	.
10 Pittsburg.	.	Pittsburg.	.	.	.	.	.	.	.	.	.	.	.	.
<b>SUMMARY</b>														
17 Railroads.	.	.	.04	.05	.06	.07	.08	.09	50-60	48-58	52-62	52-60	60-70	60-68
7 Manufacturers.	.	.	.05	.06	.07	.08	.09	.00	50-60	48-58	52-62	52-60	60-70	60-68
9 Cons. Engrs.	.	.	.06	.07	.08	.09	.00	.01	50-60	48-58	52-62	52-60	60-70	60-68
7 Universities.	.	.	.07	.08	.09	.00	.01	.02	50-60	48-58	52-62	52-60	60-70	60-68
40 Total.	.	.	.10	.11	.12	.13	.14	.15	50-60	48-58	52-62	52-60	60-70	60-68

\*Indicates the preference expressed in each case.

(Mr. Douglas, the vice-chairman, then read the following paper prepared by Mr. Snow:)

Mr. J. P. Snow (Boston & Maine) :—The work of the Committee has been more productive of labor than of results. On the subject of contracting for bridge work it is hoped that what is presented will have interest to those of our members who are buyers and sellers of bridges. On specifications for material, Mr. Condon and his committee have done yeoman service with the result of opening up a very interesting field of discussion. On the matter of live loads for bridges, Mr. Douglas and his co-workers have investigated the probable maximum weight of locomotives and the probable maximum weight per lineal foot of cars employed in various kinds of traffic, and while they have nothing ready to present as a report to the Association, they are satisfied that economy in operation demands the use of consolidation engines having from 20,000 to 25,000 pounds on each driving wheel for roads with any considerable traffic. A statement showing the recent rapid increase in the weight and capacity of rolling stock is also being prepared.

The important part of the report is the portion on which no agreement has been reached, to-wit, the class of steel to be used in our bridges. On this question the Committee have unanimously agreed to disagree, and the disagreement is quite radical, four of the nine members advocating a single grade, with average ultimate strength of 60,000 pounds, while five of the members advocate two grades with a gap between, the gap covering material from 59,000 to 61,000 pounds ultimate. The arguments advanced in favor of these two positions are given briefly in the report.

It will be seen that these two schemes are quite antagonistic. Unlike two rival schemes for coal handling or freight yard design, both cannot be recommended and users advised to take their choice. Practical commercial considerations demand that one scheme only be adopted. It is possible, of course, for an engineer to demand a certain grade of steel unlike the usual output and get it; but it involves great trouble to manufacturers, great care and watchfulness on the part of the inspectors, delay in delivery and some uncertainty in the result. It is not businesslike to use for ordinary structures material that differs greatly from that used

by others for the same class of work. Manufacturers produce the grade of goods demanded by the market. Special orders cause trouble and delay. If the general demand is for a single grade of steel with an average of 60,000 pounds, billets of as near that strength as possible will be rolled and parties wanting quite high or very low steel will be greatly handicapped in getting their supplies promptly. On the other hand, if two grades with a gap between are called for by the majority of users, billets of an average grade will be scarce and manufacturers will be reluctant to produce them, as it will break up their routine and confuse their men and methods. Hence we see that for prompt deliveries and smooth working of producing plants, one scheme only should be countenanced. From the users point of view proper bridges can be built from any of the material proposed in the report, if the designs and workmanship are right. It seems to me that greater simplicity and uniformity and hence certainty of result will be attained, if a single grade is adopted than if two grades are attempted.

The great bulk of the bridges built in this country are subjected essentially to the same class of service. Some are loaded heavier than others and carry more trains per day, but the design and not the class of material should take care of these differences. There is no valid reason why different designers should require different classes of material from which to build these structures. Personal idiosyncrasies should not be allowed to outweigh the advantages to be derived from uniform practice. The figures given on the schedule attached to the report show a jumble of small variations of ultimate strength requirements that are certainly without systematic basis and, I venture to say, were adopted without a very clear knowledge of the reason why. An expression of opinion by our Association after careful study of the question will have great weight in reducing these vagaries.

As to other features of the specifications:—The tests for rivet stock do not seem to be severe enough to develop poor material. A round bar will bend 180 degrees successfully when a rectangular section of the same material may not, hence the simple bending test prescribed in paragraph 4 is no test at all for rivet steel. It is a fair test for iron. If slightly nicked it should bend successfully around a bar of its own diameter without fracture.

Stock for hand driving should bend flat when slightly nicked with but slight fracture. At the risk of repeating what I said a year ago, I wish to make a plea for softer material for hand-driven rivets. Field rivets must be soft or they cannot be closed down. In the endeavor to soften them, men are bound to overheat them, and as the injurious effects of overheating increase rapidly with the hardness, it behooves us to use quite soft steel to reduce this risk as much as possible. I cannot understand why the International Association for Testing Materials should specify a softer material for boiler rivets than for hand-driven rivets in bridges. I think that we should recommend a material for hand driving that is as soft at least as the "extra soft" of Bulletin No. 10 of the International Association.

Regarding chemical requirements, it might be well to prescribe a minimum content of manganese where 0.04 per cent phosphorus is required in rivet steel. With such low reduction there may be danger of too much oxygen if the manganese is too low.

In the allowed variations in weight of plates it may be best to modify the allowances for plates over 100 inches wide to correspond with the scheme adopted by the American section of the International Association at its last annual meeting.

President Kittredge:—The report of the Committee is now before you for discussion.

Mr. T. L. Condon:—In order to get this matter started, I wish to supplement what has been said by Mr. Douglas and Mr. Snow. To go into the history of the work of this Committee just a little, the sub-committee on specifications drew up a specification that recommended one grade of steel, which grade is shown in the last column of the diagram accompanying this report. This was submitted to the entire Committee, which numbers nine members, and raised on the part of several members very strenuous objections. The objections were sent to me by the chairman of the Committee. I was very fully impressed with the objections, because they were well raised and were well supported by argument, and in order to facilitate matters and get things going rapidly, I got together the members of this Committee who are resident in Chicago and a modification of the first recommendation was submitted to the general Committee, which modification is embodied in the column next to the last column,

and there our troubles, if they did not begin, increased. The arguments in favor of one grade and those in favor of two grades are presented in the body of the report. (See page 234.)

These arguments present the matter very clearly. The users of medium steel do not see why they should rule out what they believe to be a very excellent grade of steel between 65,000 and 70,000 pounds, if it is to be reamed, by placing the upper limit at 65,000 pounds. Mr. Snow, in his discussion, which has been read to you, makes the statement that the same class of service is required of practically all of our bridges that are built, which is true; but the point that this Committee would raise is that structures are built in two radically different ways by different railroad companies. A large percentage of the railroads entering Chicago, and our Western roads, are having their bridge material reamed; the tonnage of reamed work is constantly increasing and is a considerable proportion of the tonnage for our Western roads. On the other hand, I am informed that the Eastern roads have not come to this reaming so generally, Mr. Schneider, of the American Bridge Company, being my authority for that statement. Of the two classes of structure, one is the class of structure where the material is punched and not reamed, and the other a class of structure where the material is punched and reamed, and the advocates of the two classes of steel are those who believe in punching and reaming together, and believe they can use a higher unit of strength where the material is punched and reamed, and they do not see why they should limit their working stresses to such a low point as is necessary for steel of 55,000 pounds ultimate strength, permissible for work that is simply punched. That is the gist of the whole argument, and the reason why some of this Committee have declined to agree on 55,000 to 65,000 pounds.

Mr. D. W. Lum (Southern Railway):—Is it proposed to ream 60,000 to 65,000 pounds steel?

Mr. Condon:—I might say those who have favored the so-called medium steel in the discussions in the Committee have done so on the theory that that steel when used in bridges should be reamed.

Mr. Lum:—Less than five-eighths?

Mr. Condon:—Yes. There are two points—the reaming not only benefits the steel by removing some of the injured ma-

terial, but it materially benefits the structure in that you are more nearly able to develop the real strength of the entire section. The question of how much reaming or how little reaming is not considered in specifications for material, and I think the trouble here has been that we have attempted to present a specification for material, not coupling it with a specification for workmanship, and that, the two must go together.

Mr. C. S. Churchill (Norfolk & Western) :—As the Eastern roads have been quoted, I would state that our specifications have been used for some years for the double purpose of acquiring both medium and soft steel structures, but whenever soft steel structures are secured it is under the unit loads given for iron, and, of course, not requiring any reaming. On the other hand, if a bridge company can more readily secure a medium steel, then they submit a plan calling for medium steel in the structure, and it comes under the medium steel portion of our specifications, so that the two go together, the work and the specifications of material.

Mr. Douglas :—I would like to read a letter from Mr. Schneider, of the American Bridge Company, which was handed to me as a member of the Committee.

"To the Chairman :—I have just read your very valuable and exhaustive report on Iron and Steel Structures, and fully agree with your recommendations, except that I do not think specifying the limit of sulphur in steel is of any importance, as sulphur has the effect of making material red short, which is decidedly objectionable to the rolling mill, and we, therefore, may depend upon the mill to see that the percentage of sulphur is properly reduced for their purpose.

"In reference to the points upon which the Committee have not been able to agree :

"(a) The range of ultimate strength and the factors depending upon it. It is my opinion, in order to make your specification acceptable to engineers who are not experts on steel, as well as to the manufacturers, it would be desirable to specify only one grade of steel for ordinary structures, to be called 'structural steel,' for which I would recommend the same grade of steel as that recommended by the minority of your Committee.

"If the recommendation of the majority of the Committee should be adopted, namely, to use two grades of steel, your specification will lose a great deal of its usefulness, as those engineers who are not experts on steel or other users of steel would be in doubt as to which kind of steel would be the best to specify, and in most cases would probably make a compromise and use a grade of steel between the two grades recommended.

"Standard specifications for structural steel have been adopted by engineers in several other countries, and have become universal standards

for those countries, and I have no doubt if your Committee can agree on one grade of steel for structural purposes and embody the same in a specification, it would be universally adopted, not only by engineers, but also by other users of steel, as well as the manufacturers. I, for my part, would be willing to accept your specification and make the same the standard of the bridge company with which I am associated. I think it is very important that in this matter the engineers should take the lead, but make your specification practical and also acceptable to the manufacturers. If the manufacturers will confine themselves to one grade of steel, we will not only be able to obtain a better and more uniform product than at the present time, but it will also enable the manufacturer to keep the ingots and blooms of that one grade of steel in stock and supply orders for short delivery, which is sometimes of the utmost importance to the purchaser.

"Steel has been used for structural work for about twenty-five years and has passed the experimental stage, and, by this time, after years of experimenting, we ought to be in a position to say what kind of steel is best suited for ordinary structures. If this matter is not settled in a satisfactory and practical manner by the engineers, the manufacturers will probably combine and make their own specification for structural steel, which will be the 'commercial steel' sold at market prices. Any other grade of steel would be 'special steel,' for which an extra price would be charged."

C. C. SCHNEIDER.

President Kittredge:—We would like to hear further discussion on this report. The Association ought to do something to help the Committee out on this one particular point where they seem to be at variance, and it should be discussed fully, if you do not care to discuss the remaining portions of the report.

Mr. Lum:—Did the five members of the Committee, who advocated the two grades of steel, say whether they want to ream the higher grade? I haven't read the report, whether they recommend reaming the higher grade.

Mr. Condron:—The report covers material only.

Mr. Lum:—I do not think you can settle that matter, unless you do consider the question of reaming.

Mr. Douglas:—Still, I think, Mr. Lum, those who advocate the two grades of steel had in mind punching without reaming the soft steel, and reaming the medium steel.

Mr. Lum:—There are many specifications in the United States using 62,000 to 68,000 pounds steel and not reaming anything under five-eighths.

Mr. Douglas:—I think reaming was intended by the members advocating the two grades of steel; is not that so, Mr. Condron?

Mr. Condron:—Reaming was certainly in the minds of the members who were advocating the two grades of steel. As I have said, I think the trouble has been our attempting to agree upon a specification for material not coupled with a specification covering the work to be done upon that material. Personally, I would not be in favor of steel of 62,000 to 68,000 pounds that you speak of, or 60,000 to 68,000 pounds for bridge work, unreamed, less than five-eighths of an inch thick. I would not favor that grade of steel, because I believe that the cheapest way to buy steel to-day is to ream it. The additional cost to the railroad company of reaming on bridge work is something under 4 per cent. It only affects the cost of shop work, it does not affect freight, it does not affect the cost of raw material, it does not increase the cost of the erection; in fact, it reduces the cost of erection. Therefore, if you are paying 4 per cent to have the metal in your bridges reamed, and, in the opinion of some—and I am one of them—the metal is worth 10 per cent more in dollars reamed, and you get 10 per cent for 4 per cent—with that conviction in my mind, I do not see how anyone can want to use steel 60,000 to 68,000 unreamed. I do not advocate reaming of unimportant details, such as occur in a great many structures, and where you do not gain anything, where you are simply tying things together, but the idea all the Committee, I believe, have expressed is in favor of reaming.

Mr. Lum:—You refer to Mr. Schneider's letter; his latest specification of the American Bridge Company calls for 60,000 to 68,000, or perhaps 62,000, pounds.

Mr. Condron:—60,000 to 70,000.

Mr. Lum:—And he reams only five-eighths and over?

Mr. Condron:—That is, unless the other man specifies it.

Mr. Lum:—That is his latest specification, although I agree with you. I think it should be reamed throughout, anything over 62,000 pounds.

Mr. W. R. Webster:—If, in the opinion of the Committee, steel from 60,000 to 68,000 is not injured more in punching and shearing than the softer steel of 52,000 to 60,000—take that as a

starter. Last year there was some discussion about using a bending test with sheared edges, which is not called for in the suggested specifications. I do not know whether the Committee made any test to satisfy themselves how much steel was injured by punching and shearing, but I think many members present do not realize the amount of injury that is done to material by punching and shearing, and you are going ahead with it in the dark when you advocate indiscriminately the use of steel of over 60,000 without reaming, so I would like to ask the Committee what their opinion is about the amount of injury done to the two grades of steel under discussion.

Mr. Douglas:—The Committee, as far as I know, thinks that steel over 60,000 pounds ultimate would be more injured by punching and shearing than less than 60,000 ultimate strength. I do not know that we know positively how much; I am pretty sure that we do not. In regard to the bending tests spoken of, that was left out of these printed specifications, because we had not all agreed to it.

Mr. Webster:—The reason I asked was, that it would have given a great deal of valuable information. Now, you admit that steel over 60,000 is injured more than steel under 60,000. We have for years used steel from 52,000 to 60,000 in ultimate strength, and 60,000 to 68,000. There is no reason why those two grades of steel cannot be used. Parties who desire to use material practically the same as iron can use the lower grade of steel, as has been done successfully, and those who desire to use a higher grade of steel without reaming, depending on the drift test to show the quality of the steel, as Mr. Cooper and some other engineers do, can use a higher grade of steel, and it will make no confusion. I think if your Committee had been called together and discussed this matter it would not have taken you half an hour to have arrived at a conclusion. There is nothing in it that need give division of opinion.

Mr. Douglas:—The objection I have to the two classes is that the separation is too great between the ultimates of the two grades of steel—the reamed and the punched steel. Personally, I think a little stronger steel than is recommended for the single grade would be better for reamed work, and a little softer steel would be better for punched work, but I accepted that as a sort

of compromise measure. I do not myself see any such great objection to the present practice of having two steels, one soft and the other medium, which meet on a line or even overlap.

Mr. Webster:—I agree with you. The way to reach it is to make a leeway of 10,000 pounds instead of 8,000—60,000 to 70,000 and 50,000 to 60,000. There you have a little softer steel for work to be used without reaming, but to put in division of 2,000 or 4,000 pounds, that is not fit for either one or the other, is not businesslike.

Mr. Douglas:—I agree with Mr. Webster. In fact, I did not see any real objection to having the two grades overlap, and I would prefer for punched work 54,000 to 62,000, and for reamed work steel having a lower limit, which is less than 62,000.

Mr. Webster:—I misunderstood you. I thought you wanted harder steel for reaming, and softer steel without reaming.

Mr. Douglas:—I do like a little harder steel for reamed than for punched work, but I do not see why the lower limit for reamed work should not be lower than the upper limit for punched work.

Mr. Webster:—There is no reason, and it has been used successfully for years here, without making any confusion.

Mr. Lum:—Is it not a fact, that where we call for medium steel, which is supposed to range from 62,000 to 68,000, we are very apt to receive metal ranging from 62,000 to 63,000, or say practically 63,000 pounds? The unit stress for the medium steel would be based on an ultimate strength of about 65,000, or an average between 62,000 and 68,000; whereas the general output is much nearer 63,000 pounds. I simply mention this, because if we use soft steel, unreamed, and medium steel, reamed, with different unit stresses, there is apt to be more difference in the unit stresses than in the ultimate strength. There are many who use medium steel, without reaming, for thicknesses less than  $\frac{5}{8}$ -inch.

Mr. Webster:—I think you will find the reason why steel of from 60,000 to 70,000 is near the lower limit of ultimate strength is, that you call for very high stretch on that steel; the elongation is pretty nearly the upper limit, and the allowance is not always made for thickness of material or the shape of the test piece from which the test is to be made, and the mills keep down near the lower limit—it would be well for the Committee to consider that

matter. I don't think the idea of the mill making one lot of steel and giving it to one customer as soft steel, and to another customer as medium steel, has the importance that is attached to it.

Mr. Condron:—If you will look at the diagram that I have referred to before, you will find that in the first column have been shown graphically the physical requirements of the so-called manufacturers' specifications, that this overlap between soft and medium steel covers a range of 2,000 pounds. A year ago this Committee came before the Association with a suggested specification which is shown in the next column, the two grades of steel meeting at 60,000, but not overlapping. Now, Mr. Lum has spoken of the average of our medium steel tests being about 63,000 pounds. The fact of the matter, as near as I can arrive at it from observation, is that with this overlap between soft and medium steel, the manufacturers naturally endeavor, as near as possible, to make all of their steel fit into that very narrow limit of 2,000, and they succeed very well. All of the steel that is manufactured does not fit into that 2,000-pound limit, but the great majority of the tests that are made come very close to fitting in there. So, if you want to call the steel that is manufactured to-day soft, you are privileged to do so; if you want to call it medium, you are privileged to do so, and the manufacturer does not lose any sleep over what you call it.

A few years ago one of our engineers, on one of the large Western roads, noticed the very thing Mr. Lum spoke of—that his tests were all down to the bottom end—and he put a clause in his specifications which he thought would cure it. He said: "The average tests of the steel shall be 64,000 pounds." I was his inspector, and one day I said: "How am I going to figure that average—on one day's work, or on one carload, or on one bridge, or on a month?" "Well," he said, "you are the inspector, and I expect you to look after that. What are you doing?" I said: "I am disregarding it." That is why these two limits are suggested. I am free to say I am not a hearty advocate of these two limits, with a gap between them, though I am one of the signers of that part of the report. I am not willing to advocate a lower limit of 55,000 pounds for reamed work. I still like the specification that was suggested here a year ago, with 2,000 pounds range for retest. I believe it is the best specification, and I do not see any

objection to the 2,000 pounds' range for retest instead of 1,000 pounds, which has been agreed on in the report of the Committee now. But, every committee has to give and take a little to get a report in at all, and it is the general sense of the Committee that should be presented. The lap of grades in the manufacturers' standard specification is responsible for only one grade of steel being manufactured to-day. There is very little of the steel in the upper range of the medium, or the lower range of the ultimate, and therefore those who favor 55,000 to 65,000 pounds steel say the manufacturers are only giving us one thing. "Let us take that; don't let us do anything else." And I might say now any specification that is put out in this country to-day for steel that is different from the manufacturers' specifications will have no weight whatever, in my opinion, unless it is supported by a very large number of users whose tonnage represents so much that the mills will gladly agree to it and gladly fill it; but no one engineer can specify anything that is a little different from the manufacturers' specifications that he does not get a letter from the United States Steel Corporation or one of its branches, saying: "We notice this clause in your specifications. Will you kindly remove it before we begin to make your steel?" And we have all removed them—it is all off.

And, another thing, this is not a good time to put anything new in specifications—it is a mighty good time to talk about it; but there will come a time when the mill capacity of this country will be very much nearer the demands of steel, and then we can get what we want, and we had better get ready for that time; but at the present time you cannot get what you want, even if you say, "I will take it out of stock."

Mr. Lum:—I would like to ask the Committee's opinion on drift tests—whether they find any trouble in having them made.

Mr. Condon:—I have been in mills that turned out considerable tonnage, and had specifications in my hands calling for drift tests. They said: "Well, have you got anything to make them with?" I said: "No; it is called for that the manufacturers shall furnish all the apparatus for testing." "Well, we have a punch over here; you can go over back of the roll-turning shop, or go some other way, three-quarters of a mile off; we have a punch over there. You take the specimens over there and get them

punched, and we are perfectly willing to make the drift test." Sometimes they send them over and a new inspector usually gets a lot of them, and after he has been inspecting a while, and none of them ever fail, he does not get so many. With the ordinary grade of steel that I have had to deal with—most of my personal experience has been in the plate mills in this city—we have had no trouble with the drift tests. It is a good test and is a valuable test, and it was inserted here at the suggestion of two members of the Committee, so that in case of dispute or in case of some steel that the inspector still wanted to satisfy himself about, it was very well to have something to fall back on—not necessarily a thing that would be used for every occasion. About the bend test on rivets, Mr. Snow apparently, in writing, overlooked one paragraph in the specifications which is very important. He says paragraph 4 is no adequate test of rivets. We grant that; but he overlooked the fact that there is at the end of paragraph 4—it says, see paragraph 9, and 9 says: "Rivet steel, when nicked and bent 180 degrees around a bar, equal in diameter to the rivet rod, shall show a gradual break, and a fine, silky fracture. A sudden crystalline fracture will be considered a failure of test, and a retest required." And I believe everyone who is familiar with rivets will grant that that is a very excellent and very useful test to make of rivet stock, and it means a good deal, and usually an engineer would rather have that than any other test.

Mr. Webster:—I would like to ask in regard to the drift test whether it is not more difficult in giving a drift test on steel of 68,000 and 70,000 tensile strength, than on steel nearer the lower limit, and if that is not another reason why the manufacturers have a tendency to get the steel low, because steel of 60,000 to 68,000, as often specified, can be used without reaming, provided it meets this drifting test?

Mr. Condon:—Naturally, the drift test is more difficult, but the usual specifications do not call for the same severity of drift test on that grade of steel as is called for on softer grades of steel, and the drifting test that is commonly provided for medium steel generally I find no trouble within the medium steel, and it has been my experience to have a specification in hand, on which a very heavy tonnage was delivered, the minimum ultimate strength of which was in the neighborhood of 63,000 pounds, and

it ranged from 63,000 and some hundred, to 72,000—it was a foreign specification. I was very much surprised at the invariably good results we got on the tests of that steel, and it was not an unusual thing for us to have tests of that steel that ran clear up to 73,000 pounds, and the rejections on that lot of steel were almost invariably because the ultimate strength was too low.

Another thing that is of interest on this question of high-carbon steel: At a meeting something over a year ago of the International Association for Testing Materials, in New York City, at which Mr. Webster was present, he will remember that the representative of the Carnegie Company made the statement that they had furnished to the Pennsylvania Railroad Company a great many thousand—I do not attempt to remember the number—of axles on their newer specifications for axles, and the tensile strength of that steel was nearer 80,000 pounds ultimate than anything else. It was above 70,000, and while the Pennsylvania Company had had repeated failures of lower-carbon steel axles up to that time, a year ago last fall, there had not been a single failure of those 80,000-pound axles recorded.

Dr. Dudley of the Pennsylvania Railroad Company was present at the meeting when that statement was made, and sanctioned it as being correct. An axle is a thing that gets the most severe punishment in service, by the continual reversal of stresses in it. It is not punched, but it gets a very severe usage. The question is, are we not unduly frightened about having a little more tensile strength in our steel; and it may be in a few years we will consider that the poorest article we can use is steel under 60,000 pounds ultimate strength. I believe that is what we will find out. Not that we have got to stay under 60,000 pounds to be safe, but that we have got to go above 60,000 to be safe, and that we must ream our holes.

Mr. Lum:—If the drift test is satisfactory, and averages from 35 to 50 per cent enlargement of the hole without apparent damage to the metal, does it appear necessary to ream? Does not the drift test indicate that such metal does not need reaming; except, of course, for field connections?

Mr. Webster:—The drift test is one of the most deceiving tests we have. It depends altogether on the angle of the drift. I can take a blunt drift, almost 45 degrees on each side, drift it into the piece and upset the metal, and then take a sharper drift

and go in and expand that hole, whereas, if I take a drift on a smaller taper, it will break it. If this Committee is going to advocate a drift test, they should specify the drifts that are to be used—the taper of the drift; then you will get some valuable information. As to taking this drift test on a steel 60,000 to 68,000 and depending on that, whether it shall be reamed or not reamed, feeling that you are absolutely secure when it meets that drift test, you are not going in the right direction. It is a good test, if properly made; but the thing is to avoid improper drifts being used—drifts that will, first of all, upset the metal, and then gradually work it out.

President Kittredge:—There is a consulting engineer in private practice in Chicago who is present with us, who is not a member of the Association. I should like to hear from Mr. Schaub.

Mr. J. W. Schaub:—I do not know that I have anything to offer, but I am heartily in favor of Mr. Condron's remarks in regard to the reaming question. The Eastern shops are not, perhaps, quite as well equipped to do reaming as the Western shops are, and that may account for the prejudice they have against reaming; but when we ream steel the material can not only be used at higher values, but we get better work and better rivets, and we can reduce the number of field rivets we have to drive, which is an important item when rivets cost about ten cents apiece to drive. Aside from this consideration, however, I do not care whether the ultimate strength is 60,000 or 70,000 pounds, as long as we work within the elastic limits of the material. I am in favor of using the medium steel, and using soft steel field rivets. That simplifies the work very much and the mills are very heartily in favor of that, and it gives one grade of material throughout.

Mr. Condron:—I would like to ask Mr. Schaub whether he would favor one grade 60,000 to 70,000 pounds rather than one grade from 55,000 to 65,000?

Mr. Schaub:—I would favor one grade of structural material with an ultimate strength of 60,000 to 70,000 pounds. The rivet steel, of course, would be soft steel.

President Kittredge:—Mr. Lum moves that the report, as a whole, be approved.

Mr. W. C. Cushing (Pennsylvania Lines):—I simply want to indorse what Mr. Webster said in regard to two grades of

steel. I feel it would be a mistake to accept one grade as recommended by the Committee from 55,000 to 65,000. I like very much better the former recommendation of 1901. The upper limit of the soft steel should be, of course, the limit of safe punching and the other grade begin from that, and it seems to me the former recommendations of 1901 met the case very much better, because the upper limit of medium steel should run to 70,000, anyhow. I would suggest that a good way to handle this report would be simply to receive this and print it, and possibly ask for a written discussion through the year, and be able then to take more definite action at the next meeting, or possibly have the Committee revise its report in accordance with the discussion before the next meeting.

Mr. Lum:—I accept Mr. Cushing's amendment.

President Kittredge:—Mr. Cushing's motion is, that the report be accepted; that during the year written discussions shall be received by the Committee, and further report be made at the next meeting. Is there any discussion on that?

Mr. Condon:—May I call attention to the fact that this committee report is two entirely independent reports, with two independent subjects? The first part of our report, under the heading, "General practice in placing railroad bridge work under contract," has met the unanimous indorsement of the Committee. It is put in a way that will be useful to our members who wish to read it, and it does not commit anybody to anything particularly; but I believe it was the purpose of our chairman to ask that this be separated from the rest. The part of the report on specifications for rolled steel is not presented in final form for your acceptance, but presented with a view to bringing out further discussion and further study.

Mr. Hunter McDonald (Nashville, Chattanooga & St. Louis):—If I understood Mr. Condon correctly, he said that the difficulty the Committee had met was the fact that they did not consider the material and the workmanship together. In the disposition of this question, if the Committee is able to do so in their next report, they ought to include workmanship as well as material.

President Kittredge:—In view of the remarks of Mr. Condon, do Mr. Cushing and Mr. Lum desire to change their motion?

Mr. Cushing:—It is acceptable to me.

President Kittredge:—We will act, then, on the two parts of the report. The first part, which I am sorry has been discussed in detail very little, in fact, not discussed at all—shall be accepted. The second part, in regard to specifications, shall be accepted as a report of progress and written discussions invited during the year.

Mr. Churchill:—There is one point about the first part of the report, in the first item on page 8, the wording of which rather conveys the impression to me that it is preferable that railroad companies shall furnish detailed plans, that is, all the details, to the bridge companies. I do not think that that was the intention of the Committee. It seems to me that the idea is that railroads should either furnish detailed plans of bridge work to bidders, complete enough at least for a precise determination of the weight of the structure, and for listing the mill orders by the successful bidder, or if such drawings cannot be furnished, the alternative method given in the report—either one or the other.

Mr. Douglas:—The opinion of the Committee is that the first method is preferable; but if any individual railroad thinks differently, it is the opinion of the Committee that it had better adopt the second method.

Mr. Edwin F. Wendt (Pittsburg & Lake Erie):—I would like to ask the Committee to define the words “detail” or “detailed plans.” As I understand it, they do not mean shop plans.

Mr. Douglas:—They may or may not include shop plans. Plans sufficient to show practically all the details, may not show the spacing of the rivets, but should show the sizes of the pins, the number of rivets in every joint, all the connections, etc., and may include full shop drawings, or may not, at the option of the railroad company. I do not think that is very material.

Mr. Condon:—And that is further qualified by the remark, “complete enough, at least, for a precise determination of the weight of the structure.”

President Kittredge:—I very much wish we could have discussed a little more in detail this first portion of the report. I feel it is necessary to put the question, as our time is limited.

(Motion carried.)

President Kittredge:—The Committee has asked, as an expression from our members, not with the idea of binding the

Association, but as an expression of the individual members of the Association, if they would express themselves on the subject of whether to have one grade of material or the two—if they would favor one grade of material or two, exclusive, of course, of the rivets. I do not see any objection to favoring the Committee in that particular, and unless there is some objection—would the Committee like to limit the ranges of those two, or simply ask for an expression?

Mr. Condron:—The Committee is anxious to know of this body of men whether they would favor the two limits, regardless of the range, or favor that one limit of 55,000 to 65,000 pounds. We would like an expression of those present, without binding the Association, whether they would favor two grades of steel, ranging one grade below 60,000 and the other grade above 60,000 pounds, or whether they would favor one grade of 55,000 to 65,000 pounds. We would like to know how many here favor two grades of steel, one below 60,000 pounds and the other above 60,000 pounds, and those who favor one grade between 55,000 and 65,000 pounds. I make that as a motion.

President Kittredge:—Well, can we not get at it by asking those who favor one grade of steel, varying from 55,000 to 65,000 pounds, to stand until counted? The chair will ask those who favor one grade of steel, ranging from 55,000 pounds to 65,000, to stand until counted. Inasmuch as this is a matter not binding the Association, I would invite those persons who are connected with bridge work, or bridge engineers, to stand also, in order that we may get their opinion for the benefit of the Committee. Those who favor one grade ranging from 55,000 to 65,000 pounds will please stand.

Those who favor the two grades of material, one ranging above 60,000 and the other ranging below 60,000 pounds, will stand until counted.

I am sorry we have not a larger vote. There are only six in the first case and 15 in the second.

Mr. H. G. Kelley (Minneapolis & St. Louis):—Some of us would like to vote on this question but have not had it put to us in such a way that we can vote. There are quite a number who favor one grade of steel, but they do not want to be limited from 55,000 to 65,000. In other words, there are a number who think it should be 60,000 to 70,000, leaving rivet steel for

everything below that, and in the way the question has been put to us, we cannot vote.

President Kittredge:—I will put another. All those in favor of one grade of steel—excluding rivet steel—ranging from 60,000 to 70,000, will please stand. Those in the first place favoring one grade, 55,000 to 65,000, are six in number; those favoring two grades, one ranging above 60,000 and the other ranging below 60,000, are 15, and 10 favor one grade, ranging from 60,000 to 70,000 pounds. That is a matter of considerable interest.

Mr. Webster:—I want to know if the gentlemen will use that one grade of steel without reaming, because to-day we are using two grades of steel, one under 60,000, without reaming, and one above 60,000, which is reamed in many cases, and I think it will assist the Committee in their work to have an expression of opinion, and ask the question again, how many men are present who will favor the use of steel, 60,000 to 70,000, without reaming?

President Kittredge:—Those who are present, whether members or not, who favor the use of one grade of steel, ranging from 60,000 to 70,000, without reaming, please stand until counted.

(No one stood.)

Mr. Webster:—I think that last vote will be of more benefit to the Committee than any we have had yet.

Mr. Condron:—This has been of considerable interest and information. I was impressed by a remark I heard at the first committee's report, the Committee on Roadway, and somebody said something about expense, and there was an objection raised that this Association should not limit itself to recommendations based on whether they could afford it or not, and I believe that is the key to the whole situation of recommendations of this Association on such an important question as bridge construction. I think we should recommend strictly first-class practice, and punching without reaming is not strictly first-class, and any railroad that wanted to build its bridges without reaming would of course be at liberty to do so, but the recommendation of the Association should be along the lines of high-grade work and high-grade material, and I believe if this Committee had not been burdened with the idea that they have to please those who wanted low-grade work as well as those who wanted high-grade work, the

thing would have been simplified, and I would recommend that the future Committee consider seriously getting up specifications which consider workmanship and material together, and present to the Association at another meeting, and I believe they will have something concrete and something the Association can vote on; but as long as we try to fill both grounds it is almost impossible.

W. R. Webster (by letter):—After carefully considering the Committee's report and the discussion at the meeting, I would suggest for the further consideration of the Committee that in order to arrive at final conclusions regarding the grades of steel to be used they adopt, as a temporary compromise, the following classes of material:

1. Unless otherwise specified, steel shall be that known as the grade "structural steel," having an ultimate strength of from 55,000 to 65,000 pounds.

2. The grade of medium steel shall be used when specified, having an ultimate strength of from 60,000 to 70,000 pounds.

3. The grade of soft steel shall be used when specified, having an ultimate strength of from 50,000 to 60,000 pounds.

In using "structural steel" and "medium steel," proper check tests should be made to show whether the material could safely be used without reaming. Such tests should have all conditions under which they are to be prepared and made clearly specified, and also the thicknesses of material to which such tests are to be applied.

If the Committee should agree upon these suggestions and call for a letter ballot of our members, the specifications could be put in force within the next few months, and then, from actual experience, could be modified as was found necessary. Of course this whole matter is governed to a large extent by the question of using steel without reaming and planing the sheared edges, and how high in ultimate strength it is safe to use steel in this manner.

I think one of the most important subjects before us is a complete series of tests, on each of the above grades of steel, showing the effect of punching and shearing material of different thicknesses, and I trust the Committee can see its way clear to undertake this work.

(Adjourned until 9:30 a. m. Thursday.)

THURSDAY, MARCH 20, 1902.

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The meeting was called to order at 9:30 a. m.

President Kittredge:—The first report to be considered this morning is that of the Committee on Yards and Terminals. The Secretary will call the names of the Committee, and as they are called the Committee will please step to the front. In the absence of both the chairman and vice-chairman of this Committee, Mr. E. E. R. Tratman will take charge of the report, and we will call on him to make any remarks he chooses in connection with the presentation of the report.

#### REPORT OF COMMITTEE No. XIV.—ON YARDS AND TERMINALS.

*To the Members of the American Railway Engineering and Maintenance-of-Way Association:*

Your Committee, in presenting its second annual report, desires to state that it has held monthly meetings in Chicago and Philadelphia, the Western members of the Committee attending the Chicago meetings and the Eastern members the Philadelphia meetings. The minutes of the meetings held at both points were sent to all members, and the minutes of the Chicago meeting were discussed at the following Philadelphia meeting, and vice versa. This was done so that a question brought up at either point would be discussed at the next meeting by the remainder of the Committee, and the final opinion of the Committee would be that of all its members. It was felt desirable to have an Eastern as well as a Western section of the Committee on account of the fact that the practice is not similar at both points.

As indicated in its first annual report, your Committee feels that the subject of yards and terminals is such an important one that it is clearly the duty of the Committee to cover it in a general way, by giving brief descriptions of the various important features and, in a broad manner, to define or outline the rules and principles which should primarily be considered in the design of yard and terminal facilities. Your Committee, in following this idea in its first report, submitted a list of terms and definitions, a description of a cluster (general yard) and an outline of the prin-

ciples governing its design. Your Committee, in its present report, submits two plans, each showing a type of cluster (general yard) as outlined in its first report. It also submits a description of the following features and an outline of the principles governing their design:

Freight-car repair yard,  
Passenger-coach and car-cleaning yard,  
Inbound freight house,  
Outbound freight house,  
Transfer house,  
Industrial district yard,  
Division terminal yard.

There is also an Appendix to the report of the Committee on Yards and Terminals, containing much information relative to the dimensions of existing freight-houses, roadways and platforms, grades of streets, size of wagons, etc., obtained by the Committee in response to a circular letter sent to members of the Association located in a number of important cities.

#### PLANS SHOWING TYPES OF CLUSTER (OR GENERAL YARD).

Two plans are submitted. They are designed in accordance with the recommendations of your Committee made in its first report. The clusters (or general yards) are especially designed to eliminate interference in the operation of yards from all causes. In preparing the plans it was found that less interference was caused to switching and road movement and the main tracks less obstructed where the engine-house is located in the center of the yard and the main tracks spread about or run around the yard; both of the types of cluster (general yard) submitted are designed with this end in view. In one of them the yard embraces receiving, separating, classification, storage and departure tracks; in other words, it has the complete series. The yard could be operated either as a poling or summit yard. The length of tracks shown is merely assumed, and could not, of course, be followed in any particular case; to meet most situations the tracks would have to be longer than shown on the plan. Tracks for special purposes, of course, would have to be developed to suit each particular locality, and they are not provided for on either of these designs. In operating a yard as shown, probably one track in the classification and one track in the separating yard would be assigned for cripple cars, and from these tracks the cars would be moved to the regular repair yard.

In the second plan the more common practice of having merely receiving, separating or classification and storage tracks is pursued. Departure tracks are not shown; they cannot usually be provided on account of the great length of the yard which they involve.

In submitting these plans for adoption the Committee desires it to be understood that they are merely types. The plan for any particular location must be developed to suit the requirements thereof.

In either of the plans the "summit" feature can be developed nicely by locating mounds between the receiving, separating and classification yards. Were it necessary to locate the cluster on a grade falling in one direction, it would usually be policy to change the arrangement of the yard; in other words, to locate the receiving yards for cars going in both directions at the upper end of the cluster (or general yard), so that the switching would all be done in the direction of the grade. This would occasion some change in the detail.

### FREIGHT-CAR REPAIR YARD.

Geographically a repair yard should be located at or near the terminal or point where cars are naturally made empty. The location selected should be such that labor and material can easily be obtained. Locally the yard should be so located that cars to and from the cluster (or general yard) and local yards and unloading points can easily be switched in and out of it without stopping work on more than the one repair track used or interfering with general yard switching. It should also be near enough to these points that switching will not be expensive.

Repair yards should be composed, as a general rule, of short tracks, of a capacity of ten (10) or fifteen (15) cars each, so arranged that they will be in pairs; the tracks of each pair should be spaced sixteen (16) feet apart centers, and the pairs should be spaced forty (40) feet apart centers.

The material supply yard for this type of repair yard should be located at the end of the repair tracks, so that material can easily be trucked into the openings between the tracks and along these openings to any point in the repair yard.

Part of the yard should be provided with air and water-pipes for testing refrigerator and other cars. Air and water connections should be spaced fifty (50) feet apart. The yard should also be drained.

In calculating the size or capacity of repair tracks, cars should be considered fifty (50) feet long, so that there will be an open space of ten (10) or twelve (12) feet at the end of each car for handling material, trucks, etc.

At points where nearly all the work done is light repairs it will sometimes be of advantage, on account of lack of room, to space part of the tracks sixteen (16) feet centers. On account of the small amount of material required in making light repairs, it can easily be moved to any car located on tracks thus spaced.

Long repair tracks are objectionable because of the difficulty in switching out the repaired cars and the delay in waiting for the entire cut of cars to be repaired. The yard should be lighted. If it is not necessary to work at night, the yard should be switched at that time, so as not to interfere with the work. Less switching and delay will be had where light repair cars are kept on tracks separate from the heavy repair cars. Light repairs are sometimes made on the yard tracks, and it will quicken the movement of cars to so arrange that there will be a track for holding cripple cars between the receiving and separating yards of a cluster (general yard). Tinker or very light repair cars should in nearly all cases be repaired on

the track on which the cars stand; they should not be moved to the regular repair yards or tracks except in exceptional cases.

The plan attached is only one of many possible types, but it illustrates the principles.

#### PASSENGER-COACH AND CAR-CLEANING YARD.

Geographically the location should be at the terminal or end of train run, and locally it should be such a location as is easy of approach to and from the terminal station or end of train run.

A "Y" track for turning trains is almost always necessary, and the movement to or from it and the yard and station should be free. In large cities the value of land will often prevent the building of a "Y," and in such cases a turntable capable of handling the largest car seems to be a necessary adjunct.

In order to avoid empty mileage and delay, this yard should be near the terminal station. It is sometimes of advantage to have it connected at both ends, but tracks connected only at one end are usually used. The yard should be composed of tracks spaced about twenty (20) feet center to center. Some space can be gained by putting them in pairs, with the tracks of each pair sixteen (16) feet centers, and the pairs thirty-six (36) feet centers. Where the value of land limits the size of the yard, and thus controls the spacing of tracks, it is felt that tracks can be reduced to fourteen (14) feet centers. This is minimum and should not be used where the greater distance can be had; it will allow the men to pass.

In some cases it will be quite an advantage to have the yard (or at least a few of its tracks) connected at both ends. If the yard is not connected at each end, at the blind end of tracks, and running at right angles thereto, a car cleaners' supply building should be located, with a space between the building and the end of tracks sufficient for the trucking of material to any of the openings between them. The building should be of sufficient size for all supplies, for electrical arrangements, boilers, dynamos, compressed-air plant, steam-heat, gas, repair material, dining and sleeping car supplies, oil, waste, etc. If the yard is connected at both ends, this building will have to be at one side, but the yard will usually work to better advantage with it at the end on account of the ease with which material can be trucked to any point in the yard.

The yard itself should be provided with water, steam and air pipes running down between alternate tracks, and, where necessary, with proper arrangements for furnishing gas and electricity. The connections should be spaced fifty (50) feet apart. The yard should be sewered between each pair of tracks. Some kind of permanent staging should be provided between each set of tracks, from which the cleaning can be done, and which will give the men employed there an opportunity to readily reach the roof of the car as well as the lower parts; a system of poles and brackets, or a trolley arrangement from overhead supports, is suggested. The yard should be well paved or planked, to allow of drainage and of being kept

clean and free from dust. A permanent paving is desirable; planking is not, as the use of soap, acids, water, etc., in cleaning will soon cause it to rot. The tracks should be of sufficient length to handle trains without cutting them. In designing the yard, the length of trains to be handled should be considered, so that the tracks may be made of proper length; where more short tracks are required the ladder can be made to run each way (see sketch of "Freight-Car Repair Yard"). The yard should be lighted so that work can be done at night where necessary.

The sketch attached is only one of many possible types of car-cleaning yards. The first, third and fifth pairs of tracks from bottom are 16 feet centers; all others 20 feet.

### INBOUND FREIGHT HOUSE.

If possible, it is well to locate an inbound freight house so that the empty cars made at the outbound houses or transfer houses can be moved directly to the inbound houses without interference or delay. In some cases, by having adjoining houses, they can be used without being switched. The location should be as convenient as possible to the business district; approach from it should be by streets the grade of which is not great enough to burden the teaming community, say not over four (4) per cent; this figure, however, will vary in each locality. In Chicago, where there are practically no grades, a four (4) per cent grade is burdensome; this would not be the case in Pittsburg, where many of the street grades are as high as seven (7) per cent.

On account of the speed with which the cars in inbound houses can be unloaded it is not often of advantage to have over two (2) tracks at the house; thus it is only necessary to unload through one car. Unloading through cars is always objectionable, as it makes the spotting of cars at the freight house necessary, unless eight (8) or ten (10) foot platforms are provided between tracks, and this spotting consumes time in getting the cars in shape for unloading at the house, thus reducing the capacity and increasing the cost. The platforms should be provided wherever space will permit of it. The arrangement of tracks should be such that the cars at the house can be pulled out and new loads set in a minimum amount of time; this is usually provided for by a small auxiliary yard, about as shown on the sketch. It should hold at least as many cars as the freight house tracks accommodate. A cut of empties is pulled back to one of the tracks in the yard and a new cut of loads shoved in. The second cut of empties is pulled out from the house and the second cut of loads shoved in. The empties are then all taken to the cluster (general yard), or to the outbound house, and a new supply of loads set in the smaller yard ready to be switched as soon as those at the house are empty. The track approach to the freight house from the main tracks should be such as not to cause delay. Where the small yard cannot be provided, a lead track should at least be built, to avoid switching on the main tracks.

The proper width of inbound freight houses is fifty (50) feet. The proper length depends upon the amount of business to be done and the

allotment of ground for the building. This also sometimes affects the width of the house.

The proper minimum width of the roadway where the inbound house is on one side of it and a wall on the other side is thirty (30) feet.

The proper minimum width of roadway where the inbound house is on one side of it and a team track or in or outbound freight house is on the other side is forty (40) feet.

The proper additional width, or the distance that the inbound house should be set back from the street where it is parallel to the street, for a space in which teams are to stand when wagon is backed against the freight house, is twenty (20) feet.

Between the side of the house and the near track there should be a platform eight (8) or ten (10) feet wide, to obviate the necessity of spotting cars at doors.

Inbound freight houses will frequently have to store large quantities of freight, and, in order to do this, and not interfere with the prompt movement of business on the first or ground floor, it is frequently necessary to build such houses several stories high, the upper floors to be used for storage. These floors should be spaced ten (10) feet apart in the clear, and material should be lifted to them in elevators and endless-chain conveyors. The lower floor is sometimes arranged to slope slightly in the direction of the load, though not much is gained by this.

The business to be accommodated must govern the style of structure, considering volume, kind and character of traffic, the time it must remain on the floor, etc. In large cities, inbound houses usually are separated from outbound and transfer houses, due to lack of room to combine them. It is best, however, where possible to do so, to at least have the in and outbound houses close together, so as to decrease the amount of light wagon mileage to a minimum; where they are together, a wagon will deliver and remove a load with no light mileage. In small towns and cities the houses should usually be combined. It is desirable to provide inbound houses with an overhead crane reaching over two tracks, a platform and a roadway, to admit of the transfer of heavy loads from car to car, platform or wagon. A cold-room should usually be provided for storing butter, eggs and other refrigerator-car freight awaiting delivery. In winter this room can be used for fruit, to prevent freezing. Checkers' offices should be located at proper intervals; they should be properly heated in winter. Electric lights on extension cords for use in cars and houses should be provided; they will soon repay their cost in quickened service. The cords should be of such length as to allow the lights to be moved about, hung on hooks, etc.

Protection against fire should be provided by placing hydrants at intervals throughout the house about one hundred (100) feet apart, each hydrant to be connected with proper length of canvas or other hose arranged on reel or folded in box, or stretched out at length on a shelf so that it can be put into instant service, and arrangements should be made with the city authorities for fire-alarm box and outside hydrants where

possible. In a recent fire on the Lehigh Valley R. R. the blaze spread so rapidly that the inside protection was not available. Water-barrels, buckets and extinguishers should be provided at proper intervals.

It is most important to provide a good, smooth floor; it accelerates the work of trucking and reduces the cost thereof, likewise decreases the amount of loss from rough handling. Hard maple makes a very good, cheap floor, and will wear for years where not exposed to moisture.

Two plans are attached, one showing the ordinary type of inbound house and the other a possible type in which inbound, outbound and transfer houses are consolidated.

### OUTBOUND FREIGHT HOUSE.

If possible, it is well to locate an outbound freight house so that the empties made at the inbound house can be moved to it without interference or delay. In some cases by adjoining houses they can be used without being switched. This plan cannot often be used, however, as unless cars for certain designated points have fixed locations, truckers are liable to make mistakes and put freight in the wrong cars. The location should be as convenient as possible to the business district. The approach to it should be by streets the grade of which is not great enough to burden the teaming community, say not over four (4) per cent; this figure, however, will vary in each locality; in Chicago, where there are practically no grades, a four (4) per cent grade is burdensome, but this would not be the case in Pittsburg, where many of the street grades are as high as 7 per cent.

On account of the delay in getting a full load into cars at outbound houses they must remain at the house a considerable time, usually all day. In large cities the tonnage shipped to many points makes it necessary to have a separate car for each station to which a necessary amount of freight is shipped. There must also be cars for the local or peddler business at small stations along various routes, each such route requiring a car. In this way the total number of cars which must be set at an outbound house is sometimes very large, and, in order to get the proper number, it is frequently necessary to load through four, five, six and sometimes seven cars. It is most important, therefore, in designing such a house to ascertain the proper number of cars which should be placed for loading at the house, and a liberal surplus for the demands of the future should be arranged for. The ordinary outbound house is shown on sketch attached, on which it is arranged to load through four or five cars. If necessary to load through more than four cars, it is advisable to see if the house cannot be enlarged in other ways.

There should be connected with these tracks a small yard for the quick switching of them, so that it will not have to be done on the main track. If possible, the capacity of this yard should be at least as large as the car capacity at the house. This small yard is not as necessary here as it is at the inbound house. The movement from outbound houses is usually made only once a day, except in cases of special shipments, and these latter

are loaded into cars at the end of the track nearest the main track, so that they can be switched or moved without interfering with other cars at the house. Between the side of the house and the near track there should be a platform eight (8) or ten (10) feet wide to prevent spotting cars at doors; also, where room is available, it is of great advantage to construct platforms about eight (8) or ten (10) feet wide between the tracks, in order to avoid the necessity of spotting cars.

Another type, although not so common, is to have the house abut upon a street and the tracks run up to it at right angles. Between each pair of tracks there should be a covered platform about twelve (12) feet wide. This house has the advantage of being able to get a large number of cars at the house without the necessity of loading through cars. The average length of the truck haul is usually decreased. Such an arrangement is frequently made where it is desirable to consolidate an in and out bound and a transfer house at one point. On one side is built the inbound house, on the other the outbound house, and between them the office. Cars to be transferred are set on the various intermediate tracks. The advantages of such a house are that the empties made at the inbound and transfer houses are quickly turned over to the outbound house, or can be used for outbound shipments, if necessary, without switching. It gets a large number of cars at the house and enables the local agency to make shipments, on account of the cars being transferred, to many points quickly. It has the advantage of consolidating three features—an inbound, an outbound and a transfer house—under one set of officers and one agent. This tends greatly to reduce the cost and also to quicken the service. The tracks at all these houses should be arranged so as to require the least amount of switching and so that it can be done in the least time. The track movements from the large cluster (or general yard) to the freight house should be such as not to require time or to be blocked; it should be a free movement. Connected with this house should be a small yard, about as shown on sketch, to enable the ready switching of the cars.

The proper width of outbound houses is twenty-five (25) feet.

The proper length depends upon the amount of business to be done and the allotment of ground upon which the building is built. This also sometimes affects the width of the house.

The proper minimum width of roadway where an outbound house is on one side of it and a team-track or in or outbound house on the other side is forty (40) feet.

The proper minimum width of the roadway where the outbound house is on one side of it and a wall on the other side is thirty (30) feet.

The proper additional width, or the distance that the inbound house should be set back from the street where it is parallel to the street, for a space in which teams are to stand when wagon is backed up against the freight house is twenty (20) feet.

The business to be accommodated must govern the style of structure, taking into consideration volume and character of traffic and the time it will have to remain on the floor, etc. In large cities outbound houses are

usually separated from inbound and transfer houses, due usually to lack of room to combine them. It is best, however, where possible to do so, at least to have the in and outbound houses close together, so as to decrease the amount of light wagon mileage to a minimum. Where they are together a wagon can deliver and remove a load without any light mileage. In small towns and cities the houses should usually be combined.

It is desirable to provide outbound houses with an overhead crane reaching over two tracks, a platform and a roadway, which will admit of the transfer of heavy loads from car to car, platform or wagon. A cold-room should usually be provided for storing butter, eggs and other refrigerator-car freight awaiting loading. In winter this room can be used for fruit or vegetables, to prevent freezing. Checkers' offices and scales should be located at proper intervals; scales should usually be provided at each door. These offices should be properly heated in winter. Electric lights on extension cords, for use in cars and houses, should be provided. They will soon repay their cost in the quickened service. The cords should be of such length as to allow the lights to be moved into cars, hung on hooks, etc.

Protection against fire should be provided by placing hydrants at intervals throughout the house, usually about one hundred (100) feet apart, each hydrant to be connected with proper length of canvas or other hose arranged on a reel or folded in a box, or stretched out at length on shelves, so that it may be put into immediate use. Where possible, arrangements should be made with the city for fire-alarm box and for outside fire-hydrants. In a recent fire on the Lehigh Valley R. R. the blaze spread so rapidly that the inside protection was not available. It is also well to provide water-barrels, buckets and extinguishers at proper intervals.

It is most important to provide good, smooth floors. It facilitates trucking and reduces the cost thereof, also decreases the amount of loss from rough handling. Hard maple makes a good, cheap floor and will wear for years, where not exposed to moisture.

Three plans are attached, one showing the ordinary type of outbound house, a narrow house with parallel tracks; a possible type, not so common, with narrow house and tracks running up to the same and at right angles to the house, covered platforms being provided between tracks; also a possible type in which the inbound, outbound and transfer houses are consolidated. These, of course, are merely types, showing possible developments. Many others could be furnished.

#### TRANSFER HOUSE.

Geographically the location should be at some junction point or points where there is a coming together or bunching up of the traffic and where there is a yard and a natural lay-over point at which the traffic is switched and trains are broken up, or at a point where one railroad terminates and another begins and it is desired to avoid having the cars of one road run on the other road. Locally, where possible to do so, it should be located

with the in and outbound freight houses, so that one agent and one set of foremen may have charge of all.

The purpose of a transfer house is the consolidation of less-than-carload lots into carload lots and the breaking up of cars containing shipments to many points and consolidating them into cars containing shipments for only one point or route, or the transfer of freight from car to car to avoid the use of foreign cars. In order to do this it is necessary to be able to set a large number of cars at the house. A transfer house makes cars, or, in other words, by consolidation releases loaded equipment. It is, therefore, of some advantage to have it located at such a point where the equipment thus released can be used.

It is usually made up of a series of tracks in pairs, with covered platforms about twelve (12) feet wide separating each pair. It should be so located that the supplying of cars for the transfer house to and from the yards can be done without delay.

In second-class cities, or at junction points, the transfer house must in most cases be considered in connection with the regular station work and should be designed with this end in view. The same care to provide proper fire protection, good floors, cranes for heavy loads, proper lighting, etc., should be taken as in the case of inbound houses.

The attached plan shows a type of transfer house consolidated with in and outbound freight houses.

#### INDUSTRIAL DISTRICT YARD.

Large cities are usually divided into what are called industrial or switching districts. In each of these districts one or more engines are required to switch the team-track, freight house, business sidings, etc. If the terminal cluster (general yard) is some distance from these districts, it is customary to run cars into the district from the cluster (general yard) to a small district yard by what is called a transfer engine. These engines leave the cars in the district yard and they, in turn, are then delivered by the district engine to the point where needed.

The yard is usually only a number of parallel tracks, on which cars are set. These parallel tracks should be so arranged with a switching lead that they can be switched without interference with the main track, about as shown on the attached plan.

#### DIVISION TERMINAL YARD.

At many points this type of yard is only needed for trains to pull into, change engines and cabooses, cut off or add a few cars to correct the tonnage for the next division, and pull out, such a movement being called by the English "a bull-pen" movement.

In connection with this yard there should be a small lancing yard in which to put cars for the local trains in station order. (At points where the amount of additional business is great and trains must be broken up

into many new parts, the yard takes on the features of a terminal cluster and should usually be so designed.)

In this type of yard it is most important to get the movement of engines from house and coal-dock to and from yard so planned that there will be no interference or delay. The yard is usually at a division end and is primarily a holding-place while engines, crews and cabooses are changed. It is at the intermediate end of train runs and any land upon which the yards can be built will answer. It should, however, be so located that the men can get to and from it without much inconvenience, and that cars for the city or town in which the yard is located can be switched to and from the city delivery tracks or freight houses without delay. It should not be located on a limiting grade unless it runs with the traffic. When the necessity for breaking up trains exists, the yard will then assume the features of a cluster (or general yard). The size of the yard depends upon the volume of business and is best measured by the number of trains arriving per hour. The location of the engine house is most important, but must be governed almost entirely by local conditions. It should be studied with much care, so as to locate it where the movement of engines to or from the yards will cause a minimum amount of interference. The plan attached illustrates one of the many simple types of division terminal yard.

In order to get its subjects well in hand your Committee has not gone into the minor details of the various matters treated, but has tried to bring out the principles or rules most essential in the consideration of design. This is done in order that it may cover the entire ground in a general way at the earliest possible time, thus giving the Association the greatest amount of information in the least time, the smaller details on each subject to be developed in future reports. It should be remembered that, from its very nature, the Committee is almost limited to principles and not details. Illustrating this, it would not be proper for the Committee to outline the construction of a freight or transfer house or the manner of building a track; it is, however, within its province to describe the manner of operating a freight or transfer station or the switching of a yard or terminal. Therefore, in giving these descriptions, many of the details which enter into the maintenance and engineering questions involved in the proper handling of the whole property will be brought to the attention of the Association by your Committee in its future reports.

### CONCLUSIONS.

Your Committee begs to submit the following conclusions for adoption by the Association:

*Cluster (or General Yard).*—In the development of a cluster (or general yard) less interference is caused to switching and road movement, and the main tracks are less obstructed, where the engine-house is located in the center of the yard and the main tracks run around the yard.

*Freight-Car Repair Yard.*—A repair yard should be composed of short tracks. The spacing of tracks on which light repairs are to be made should be less than that for tracks on which heavy repairs are to be made.

*Passenger Coach and Car Cleaning Yard.*—The yard should be at such a location as to be of ready and quick access to and from the station. The tracks should be of such length that they will accommodate trains without cutting. Better results will usually be obtained with stub tracks and a car cleaners' repair and supply building located at right angles to them at the stub end of tracks.

*Inbound Freight House.*—This house should be of such width as will furnish a reasonable amount of floor space for the holding of freight. (Fifty (50) feet is a good average width.) Usually not over two tracks are needed. These tracks should be provided with platforms to avoid the necessity of spotting cars.

*Outbound Freight House.*—In order to decrease trucking at this house it should be of narrow width. (Twenty-five (25) feet is a good average width.) It is of advantage to have a great number of cars at the house so that all freight can be loaded into the cars direct. It is not advisable to load through more than four (4) cars. These tracks should be provided with platforms to avoid the necessity of spotting cars. Where a great number of cars are required the trucking distance will usually be decreased by having stub tracks running up to the freight house, which is at right angles to them; these tracks to be separated by covered platforms leading to the freight house. In addition to decreasing the trucking distance, this type avoids trucking through cars.

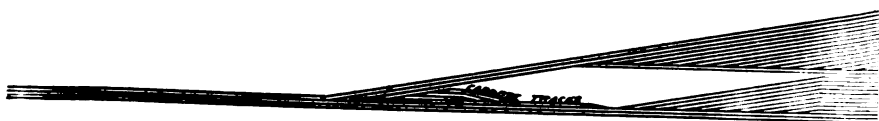
*Roadways.*—Where the freight house is on one side and a wall on the other side, the proper minimum width of roadway is thirty (30) feet. Where a freight house is on one side of it and a team track or other freight house is on the other side, the proper minimum width of roadway is forty (40) feet.

*Transfer House.*—A transfer house should be located at a point where there is a coming together of the traffic and a necessity exists for its consolidation, and where the loaded equipment made empty can be used.

Respectfully submitted,

C. S. SIMS, Superintendent, Pennsylvania Lines West, Chicago, *Chairman*;  
 W. G. BESLER, Gen. Supt., P. & R. Ry., Reading, Pa., *Vice-Chairman*;  
 E. E. RUSSELL TRATMAN, Resident Editor, Engineering News, Chicago;  
 R. B. TWEEDY, Chief Engineer, Wisconsin Central Ry., Milwaukee, Wis.;  
 S. P. HUTCHINSON, V.-P. and Gen. Man., El Paso & S. W. R. R., N. Y.;  
 J. B. COX, Chief Engineer, Chicago Junction Railway, Chicago;  
 J. A. ATWOOD, Chief Engineer, Pittsburg & Lake Erie Railroad, Pittsburg;  
 G. F. MORSE, Assistant Engineer, Lehigh Valley Railroad, Buffalo, N. Y.;  
 A. W. SWANITZ, Chief Engineer, Chicago Tr. & Cl. Co., Chicago;  
 M. S. BLAICKLOCK, Res. Engineer, Grand Trunk Ry., Montreal, Can.;  
 W. K. MCFARLIN, Chief Engineer, D., L. & W. R. R., Hoboken, N. J.;  
 I. G. RAWN, Gen. Supt., Baltimore & Ohio S. W. R. R., Cincinnati, O.;  
 J. G. RODGERS, Superintendent, N. Y., P. & N. R. R., Cape Charles, Va.;  
 F. S. STEVENS, Superintendent, Phila. & Reading Ry., Reading, Pa.;  
 W. S. KINNEN, Asst. Supt., Mich. Cen. R. R., St. Thomas, Ont., Can.:

*Committee.*





## APPENDIX TO REPORT OF COMMITTEE ON YARDS AND TERMINALS.

In order to ascertain the actual conditions existing at large terminals, a circular letter was sent out to officers in a number of cities, and the information thus obtained is presented herewith in order that it may be on record:

## BOSTON, MASS.

*Boston & Maine R. R.*—Mr. F. O. Melcher, Superintendent of the Fitchburg Division, sends the following statement:

1. Width of inbound freight houses.....40 feet.  
Width of outbound freight houses.....30 feet.
2. Width of platform along outside of freight houses.....No platforms.
3. Width of platform for trucking between tracks.....None.
4. Width of driveways in yards where one or both sides are used for loading or unloading (clear width between sides of cars) .....27 to 35 feet.
5. Width of driveways at freight stations, where one or both sides are used for loading or unloading.....45 feet.
6. Street grades in business districts.....Practically no grades.
7. Average and maximum loads of wagons, in tons.....4 tons.  
Greatest load known here .....24 tons.
8. Total length of wagon, including horses, 2-horse team, 25 feet; 4-horse team.....45 feet.
9. Length of wagon with horses turned.....20 feet.
10. Width of wagons, over all.....10 feet.

## BUFFALO, N. Y.

No.	Name of Railway.	Driveway or Teamway.	Location.	Width. Ft.
1	Lehigh Valley...	Driveway...	Scott Street (Freight House)..	48.5
2	" "...	Teamway...	Washington and Scott Streets.	16.3
3	N. Y. Central...	Driveway...	Carroll Street (Freight House).	38.
4	" "...	Teamway...	Chicago and Carroll Streets...	29.
55	" "...	" "...	" " " " " " " " " " " "	28.3
6	Pennsylvania...	Driveway...	Carroll Street (Freight House).	38.
7	" "...	Teamway...	Louisiana and Carroll Streets.	26.7
8	Erie.....	Driveway...	Exchange St. (Freight House).	54.
9	L. S. & M. S....	" "...	Louisiana St. (Freight House).	33.5
10	" "...	Teamway...	" " " " " " " " " "	22.
11	Wabash.....	Driveway...	" " " " " " " " " "	42.3
12	N. Y. Central...	Teamway...	Perry Street .....	16.3

For Nos. 1, 3, 6 and 8 the width given is the clear width to curb line, these freight houses being built on the street line.

No. 11 has no teamway.

No. 12 is for loading grain.

The streets are generally level; the maximum grade is 4 per cent.

Mr. G. F. Morse, Assistant Engineer of the Lehigh Valley Railroad, sends the following: The condition in Buffalo is such that local conditions govern the width of freight house and distances between tracks for team delivery driveways. The following tables will show the measurements of the houses and driveways as they exist. All houses are used for both inbound and outbound business.

DESCRIPTION.	Width of House.	Width of Driveway in Front of House.
L. V. R. R.; Scott Street.....	25 feet.	48.5 feet.
N. Y. C. & H. R. R. R.; Carroll Street....	49 "	38.0 "
P. R. R.; Carroll Street.....	38 "	38.0 "
Erie R. R.; Exchange Street.....	*69 "	54.0 "
L. S. & M. S. Ry.; Louisiana Street.....	50 "	34.0 "
Wabash R. R.....	25 "	42.9 "

\* Two tracks inside of house.

All houses except those of the Wabash Railroad front on a street, and the width of the driveway is governed by the curb on opposite side of street. The driveway in front of the Wabash Railroad houses is measured to the cars standing on the track opposite the house.

The above are the principal local delivery freight houses in Buffalo. There are other houses where the freight is delivered from cars to boat, and vice versa. These houses are of all widths upward of 100 feet, the widths being governed by a street on one side and dock on the other. The only case where the width was not governed by local conditions is in the Lehigh Valley Railroad lake freight houses, which are 116 feet wide, with two tracks in the inside of the house next to the wall.

Width of teamways or track delivery roadways (distances given are between cars standing on track):

L. V. R. R., Scott St.....	16.3 feet.
N. Y. C. & H. R. R. R., Chicago St.....	29 feet.
P. R. R., Louisiana St.....	27 feet.
L. S. & M. S. R. R., Louisiana St.....	22 feet.
N. Y. C. & H. R. R. R., Perry St.....	16.3 feet.

The New York Central & Hudson River Railroad roadway at Perry street is used for loading grain, the wagon standing parallel with the tracks.

The maximum grade for streets in Buffalo is 4 per cent, excepting a few streets in the residential section. The entire business section is practically level, the grades occurring on the approaches of the viaducts and subways over and under the railways, which are 4 per cent in all cases.

The measurements of wagons used in Buffalo vary from the small grocery wagon to the very large trucks. The largest are 8.2 feet wide over all; the width of roadway occupied by wagon with horse turned at right angles is 18.3 feet. Grain trucks are generally 7 feet wide and of various lengths. In all cases these trucks stand parallel to cars when loading.

## CHICAGO, ILL.

Tables A and A' have been prepared by Mr. C. S. Sims, Superintendent of the Chicago Division of the Pennsylvania Lines, and Chairman of this Committee. It gives the measurements of driveways at the freight houses in Chicago, and the distance between team tracks; also the measurements of wagons, giving total length and length with horses turned at right angles.

The measurements of driveways and teamways were made between curbs when paved, and between cars when not paved, as in most cases the curbing was directly under the side of the car.

All items marked (\*) are used for loading at one side only; all others can be used at both sides.

*Chicago & Northwestern Railway.*—Mr. R. H. Aishton, General Superintendent, has furnished a tabular statement for all the company's Chicago freight houses, which was specially prepared for the purpose by Mr. R. C. Sattley, Engineer of Bridges and Buildings. This statement is given in Table B.

*Illinois Central Railroad.*—Mr. H. McCourt, Superintendent, has furnished the following statement in relation to his company's freight houses and team traffic in Chicago.

1. Width of inbound freight house.....100 feet.  
Width of outbound freight house..... 56 feet.
2. Width of platform along outside of freight houses..... 8 feet.
3. We have no platforms for trucking between tracks.
4. Width of driveway in yards, where one or both sides are  
used for loading or unloading between sides of cars..... 25 feet.
5. Width of driveways at freight stations where one or both  
sides are used for loading or unloading varies....Average 30 feet.
6. Street grade in business district.....Practically level.
7. Average and maximum load of wagons....3.5 and 5 tons, respectively.
8. Total length of wagon, including horses.....Average 22 feet.
9. Length of wagon with horses turned.....14 to 16 feet.
10. Width of wagon, over all..... 7.5 feet.

## CINCINNATI, O.

*Cleveland, Cincinnati, Chicago & St. Louis Railway.*—Mr. Geo. W. Kittredge, Chief Engineer, has furnished the following information relating to the Central Avenue freight house in Cincinnati. This building has the inbound and outbound platforms under one roof, separated by a 64-foot driveway.

1. Width of inbound house, 33 feet 4 inches; outbound  
house.....24 feet 8 inches.
2. Width of platform along outside of freight house.....6 feet.
3. Width of platform for trucking between tracks.....5 feet.
4. In the bulking yard adjacent to the freight house the drive-  
ways are 30 feet wide between sides of cars.
5. Width of driveways at freight station where both sides  
are used for loading or unloading.....65 feet.
6. Street grades in business districts run as high as 12 per  
cent maximum.
7. Maximum load of wagons in tons (one-horse wagon).....2 tons.
8. Length of wagon, including horses.....24 feet.
9. Length of wagon with horses turned.....12 feet.
10. Width of wagon, over all.....6 feet 4 inches.

## NEW YORK, N. Y.

*New York Central & Hudson River Railroad.*—The statement given in Table C has been furnished by Mr. W. J. Wilgus, Chief Engineer, who also gives the following general list of maximum grades in the business districts of New York City, south of Forty-second street:

34th St., Lexington to Park.....	5	per cent.
35th St., 3d to Lexington.....	5	"
36th St., 3d to Lexington.....	6	"
37th St., 3d to Lexington.....	6	"
Park Ave., 40th to 42d St.....	4	"
5th Ave., 35th to 37th St.....	5½	"
7th Ave., 24th to 26th St.....	1.7	"
38th St., 11th to 12th Ave.....	1.1	"
Wall St., Broadway to Nassau.....	1.7	"
23d St., 5th to 6th Ave.....	.6	"
Broadway, 14th to 17th St.....	.2	"
40th St., Lexington to Park Ave.....	4.7	"
Rector St., Broadway to Church St.....	5	"

The loads of wagons range from 100 pounds to a maximum of 5 tons. The total length of wagons, including horses, is 29 feet; length with horses turned, 15 feet 6 inches; maximum width of wagons over all, 7 feet 6 inches.

## NEW ORLEANS, LA.

*Illinois Central Railroad.*—Mr. O. M. Dunn, Superintendent at New Orleans, sends the following information:

"Buildings used by us for inbound and outbound freight houses are, with one exception, old cotton compress buildings, remodeled to meet our requirements and are not uniform in width; some are closed and others are open and range in length from 200 to 310 feet, being located on city squares of ground with streets intervening. These warehouses vary in width from 52 to 71 feet; some of them are closed on four sides and others are open sheds on the side next to the track. In addition to these warehouses we have a number of cotton sheds varying in width from 100 to 124 feet; they are open on all four sides. We have one shed 90 feet in width and 500 feet long, in which we handle perishable business. We have two double outward warehouses with a driveway in the center, 35 feet in width.

"The grades of the streets in New Orleans are uniformly level. The average load of a wagon is about 2½ tons, the maximum load being 4 tons. The total length of wagons, including horses, is 42 feet. Total length of wagon with horses turned, is 20 feet. Width of wagon, 6½ feet over all."

## PHILADELPHIA, PA.

*Philadelphia & Reading Railway.*—The following information has been furnished by Mr. W. G. Besler, General Superintendent:

1. Width of inbound and outbound freight houses.....37 feet.
2. Width of platform along outside of freight houses.....6 feet.
3. Width of platform for trucking between tracks.....15 feet.
4. Width of driveways in yards where one or both sides are used for loading or unloading (clear width between sides of cars).....about 26 feet.

5. Width of driveways at freight stations, where one or both sides are used for loading or unloading. At Thirteenth and Callowhill streets the width between inbound and outbound buildings is .....60 feet.
6. Street grade in business district (average and maximum) . . .5 per cent.
7. Average and maximum loads of wagons; two-horse teams, 2 net tons; some three-horse teams haul five tons.
8. Total length of wagon, including horses, average, 26 feet 6 inches; maximum, 27 feet 6 inches.
9. Length of wagon with horses turned, average, 18 feet; maximum, 19 feet.
10. Width of wagon, over all: Average, 6 feet 2 inches; maximum, 6 feet 5 inches.

## PITTSBURG, PA.

*Pittsburg & Lake Erie Railroad.*—To Mr. J. A. Atwood, Chief Engineer, the Committee is indebted for a set of sketch plans of all the freight stations in Pittsburg and Allegheny. As the actual layouts in various cities differ so widely (owing largely to local conditions), and as your Committee's purpose is rather to lay down governing principles than to show actual existing plans, it has not been deemed advisable to reproduce these plans with the report. The following is a summary of the information given:

	Maximum.		Minimum.		Average.	
	Ft.	In.	Ft.	In.	Ft.	In.
1. Width of inbound and outbound freight houses .....	205	0	13	6	68	0
2. Width of platform along outside of freight houses .....	24	6	3	6	12	0
3. Width of platform for trucking between tracks .....	12	0	8	6	10	3
4. Width of driveways between tracks where one or both sides are used for loading or unloading (clear width between sides of car) .....	65	0	18	0	31	0
5. Width of driveways at freight stations where one or both sides are used for loading and unloading (only one in Pittsburg) .....	37	6				
6. Street grades in business districts....	3.7½%				3%	
7. Average and maximum load of wagons						
8. Length of wagon including horses...	26	6	22	0	24	3
9. Length of wagon with horses turned	16	6	12	6	14	6
10. Width of wagon over all .....					6	6

## ST. LOUIS, MO.

Mr. A. J. Davidson, General Superintendent of the St. Louis & San Francisco Railroad, has furnished a tabulated statement for several of the railways in that city, and this is given in Table D.

## SAN FRANCISCO, CAL.

*Southern Pacific Railway.*—Mr. J. L. Frazier, Superintendent, has furnished answers to the questions asked as nearly as practicable. There are a large number of freight sheds which differ in width and length. The teams which handle freight vary in size from small wagons hauling 1,000 pounds or more, to immense four-horse trucks hauling 10 tons. The surface of the city is much broken up; the business portion of it, however, is practically level.

1. Width of inbound and outbound freight houses.....30 to 75 feet.
2. Width of platform along outside of freight houses.....4½ to 5 feet.
3. Width of platform for trucking between tracks.....None.
4. Width of driveways in yards where one or both sides are used for loading or unloading (clear width between sides of cars) .....40 to 45 feet.
5. Width of driveways at freight stations, where one or both sides are used for unloading or loading.....48 to 51 feet.
6. Street grade in business districts.....Ave., 0.5%; max., 4½%
7. Average and maximum load of wagons.....1 to 10 tons.
8. Total length of wagon, including horses.....20 to 40 feet.
9. Length of wagon with horses turned.....12 to 30 feet.
10. Width of wagons, over all.....5½ to 9 feet.

TABLE A¹—MEASUREMENT OF WAGONS AT CHICAGO.

No.	Total Length, Including Horses.	Length with Horses Turned. Feet.	Width, Feet.
1	28½	17	7
2	22	12½	7
3	25	15	7½
4	31	22	8½
5	27	16	7½
6	27½	17½	7½
7	27½	17½	7
8	27	15½	7½
9	26	15	7½
10	25	14	7
11	26	15½	7½
12	26	17	7½
13	26	15½	7½
14	24	14½	7
15	25	15½	7½
16	25	15½	7½
17	25	15½	7½
18	28½	19	6

TABLE A—FREIGHT TERMINALS AT CHICAGO.  
MEASUREMENTS OF DRIVEWAYS AND TEAMWAYS.

No.	Name of Railway.	Driveway or Teamway.	Location.	Width, Feet.	No.	Name of Railway.	Driveway or Teamway.	Location.	Width, Feet.
1	C. H. & Q.	Teamway.	16th and Union.	29½	34	C. R. I. & P.	Driveway	Taylor and Clark.	35
*2	"	Driveway.	Harrison.	42½	35	"	Teamway.	"	36
3	"	Teamway.	Polk.	21½	36	"	"	"	37
4	"	"	"	19½	*37	A. T. & S. F.	Driveway	12th and State.	24
5	"	Driveway.	"	44	38	Monon.	Teamway.	Taylor and Clark.	26
6	"	Teamway.	"	35	39	N. Y. C. & St. L.	"	"	24
7	C. & A.	"	Van Buren.	26	*40	"	Driveway	"	24
8	"	"	"	29	41	"	Teamway.	"	26
9	"	Driveway.	Saugamon.	62½	42	G. T.	Driveway	12th and Clark.	28
10	C. M. & St. P.	Teamway.	"	18½	43	L. S. & M. S.	Teamway.	Pacific Ave.	39
11	"	"	"	17	44	I. C.	Driveway.	Randolph St. Pier.	21½
*12	"	Driveway.	Halsted.	25	45	"	"	"	25
13	"	Teamway.	Clinton.	16½	46	"	"	"	25
14	"	"	"	19	47	"	"	"	25
15	"	"	"	19	48	"	"	"	25
16	"	"	"	19	49	W. C.	"	South Water.	24
17	"	Driveway.	"	30	50	"	"	"	26
*18	"	"	Jefferson.	26½	*51	"	Driveway	"	25
*19	"	"	Desplaines.	20½	52	"	"	"	35
*20	"	"	Union.	6½	*53	M. C.	Teamway.	"	27
*21	"	"	Grand Avenue.	26	54	"	"	"	37
22	"	Teamway.	"	24	55	"	"	"	29
23	C. & N.-W.	"	16th and Jefferson.	30½	*56	"	Driveway	Green Street.	25 to 43
24	"	Driveway.	State and Kinzie.	46	57	P. C. & St. L.	Teamway.	"	31
*25	"	"	"	30	*58	"	Driveway.	"	29
26	G. T.	"	N. Canal.	66	*59	"	"	Milwaukee Ave.	19½
27	G. T.	Teamway.	12th and Ogden.	26	*60	"	"	"	33
28	C. & E. I.	"	12th and Clark.	23	*61	P. F. W. & C.	"	Van Buren.	27
29	"	"	"	23	*62	"	"	N. of Van Buren.	30
*30	"	Driveway.	"	22	*63	"	"	"	46
*31	Wabash.	Teamway.	"	21	*64	"	"	"	34
32	"	"	"	25	*65	"	"	S. of Madison.	22
*33	C. R. I. & P.	Driveway.	Taylor and Clark.	27	*66	"	"	Madison.	22

**TABLE C—NEW YORK CENTRAL &  
FREIGHT HOUSES AND TEAM TRAFFIC IN**

NEAREST STATION.	Name of Freight House.	Width of House.	Platform Along Out-side of House.	
			Location.	Width.
	Barclay St. Piers	48.0		
	" " Blk. Hd.	45.0		
	" " "	53.0		
St. Johns Park	St. Johns Park	440.0	Beach St. Side.	5.0
"	"		Laight "	4.4
"	"			
Thirtieth Street.	W. Bound Freight House.	36.3	W. of House	89.4
"	E. " "	49.6	S. " "	4.2
"	" " "		N. Side	8.2
"	" " "		W. " "	52.0
"	Bulkhead Shed	44.4		
"	"			
"	Hay Shed No. 1	52.0	N. Side	4.0
"	" 2	53.7	S. Side	4.4
"	Manhattan Market {	44.8	S. Side	5.8
"	" S. House {		N. " "	10.3
"	" Market {		S. Side	10.0
"	" N. House {	45.2	N. " "	4.0
"	" Market {			
"	Milk Platform,			
"	90th St. and 10th Ave.	None.		16.0
Sixtieth Street	Bulkhead Platform			12.0
"	Roadway			
Manhattan	Freight House.	57.9	W. Side.	12.9
"	"		N. " "	13.3
"	"		S. " "	13.0
Spuyten Duyvil.	"	25.0	W. " "	6.0
"	"		E. " "	8.0
"	"		S. " "	8.0
Grand Central Station	Milk Depot.	None.	N. Platform.	11.5
"	"		S. " "	11.5
Mott Haven.	M. O. Yd. N. House	26.8	N. Extension.	15.9
"	" " "		N. End.	19.5
"	" " "		W. Side.	6.0
"	" S. House.	28.0		
"	Driveway	None.		
Bronx Park	Freight House	14.9	E. Side.	5.9
"	"		N. " "	9.9
"	Driveway.			
William's Bridge.	Freight House.	13.7	E. Side.	5.3
"	"		S. " "	10.3
"	"		W. " "	5.2
Westchester Ave. Yard.	Milk Platform.	None.		12.2
High Bridge	"			8.0
"	"			12.8
Morris Heights.	Siding	None.		None.
Van Cortlandt	Freight House.	9.0	E. Side.	4.2
"	"		W. " "	4.2

HUDSON RIVER RAILROAD.  
THE CITY OF NEW YORK.

Width of Platform Between Tracks for Trucking.	Driveways Between Tracks.		Driveways Not Between Tracks.		REMARKS.
	One or Both Sides Used.	Width.	One or Both Sides Used.	Width.	
49.4			Both One	24.0 25.0	Between Platforms Nos. 4 and 5. Between Platform No. 2 and a wall.
			Both One	50.6 50.2	Between East and West Bound Freight Houses.
	Both Both	34.0 35.0			Between 32d and 33d Streets. Between 33d and 33d Streets.
			One One One	29.0 29.0 40.0	"Driveway" is 34th Street.
	Both	34.0			Between the two Houses.
Bet. Tr. and Blk. Hd., 81			One Both One Both	41.5 30.5 21.5 69.0	"Driveway" is 35th Street. Sidetrack on South Side of Driveway. Roadway is between Piers D and E, East of Office.
			One One	30.0 St. over 100	
			One One Both One Both One	35.0 35.0 27.0 37.0 20.0 31.5	Milk Depot bet. 4th and Lexington Ave. and 46th St.
			" " " "	24.0 24.0 24.0 69.0	
	Both	35.9			
			One " " "	25.5 25.5 34.0 L'rg Space	Unload from Door in Freight House.
			One " "	29.8 Open Space & Wide St.	
			One "	18.0 35.0	Platform Near Street Line. Driveway is Width of St.



TABLE D.  
FREIGHT HOUSES IN ST. LOUIS.

RAILWAYS.	Width Inbound and Outbound Freight Houses.	Width Platform Along Outside Freight Houses.	Width of Platform for Trucking Between Tracks.	Width of Driveways Where One or Both Sides are Used for Loading or Unloading. Clear Width.	Width of Driveways at Freight Station where One or Both Sides are Used for Loading or Unloading.	Street Grade in Business Districts.		Load of Wagons, Tons.		Total Length of Wagons, including Horses.	Length of Wagons Turned in Feet.	Width of Wagons Over All.
						Average.	Maximum.	Average.	Maximum.			
Franklin Ave. - Burlington - O'Fallon St. ....	( 133 ft. ) ( 60 ft. )	None 5 ft. 6 in.	None None	20 ft. 25 ft.	E. Side, 38 ft. ; W. " 45 ft. ; E. " 30 ft. ;	0.0 0.0	7½ 6½	5 5	10 10	23 to 28 ft. 23 to 28 ft.	15 to 18 15 to 18	5 ft. 6 in. to 8 ft. 5 ft. 6 in. to 8 ft.
M., K. & T., same as Burlington.												
Inbound ..... St. L. Term. R.R.A. - Outbound .....	( 50 ft. ) ( 133 ft. )	8 ft. None	10 ft. 10 ft.	50 ft.	N. Side, 26 ft. ; S. " 50 ft. ;							
Up ..... Wab. Dble. Deck - Down .....	( 72 ft. 6 in. ) ( 45 ft. 6 in. )	None 4 ft. 6 in.	None None	None 29 ft.	60 ft.							
Mo. Pac. -												
Biddle St. .... St. Louis & S. F. - Seventh St. ....	( 30 ft. ) ( 119 ft. )	None	None	30 ft. ( N. Side, 28 ft. ; S. " 25 ft. )		1½		2½	4	23 ft. 3 in.	15	6 ft.

Mr. E. E. R. Tratman (Engineering News):—I think the best and quickest thing we can do is to take up the consideration of the recommendations in the report. The Committee has held a large number of meetings during the year and brought together a pretty complete report. They have drawn up, at the request of the Board of Direction, a series of conclusions which represent the gist of the report. I think, perhaps, the best way will be for me to read each of these in turn, and let them be discussed and passed upon in their order. The first conclusion is as follows:

“Cluster (or General Yard).—In the development of a cluster (or general yard) less interference is caused to switching and road movement, and the main tracks are less obstructed, where the engine house is located in the center of the yard and the main tracks run around the yard.”

President Kittredge:—This report of the Committee on Yards and Terminals is probably the one report, more than any other, which has been submitted on lines which the Board of Direction has tried to have followed by all the committees; and if you will pardon me for just a moment, I will say for the Board of Direction that they have labored long and earnestly to bring about a general line of committee-work, which this report represents. We have endeavored to have all the committees present the results of their work in approximately this manner. This report is presented in such shape that the Association ought to be able to act on it intelligently and definitely. The Committee has held numerous meetings and the results of their work are apparent in the report. We will now consider the conclusions as they are submitted by the Committee, taking them up in their order. Discussion is now open on the first paragraph of the conclusions, relating to cluster or general yard.

Mr. W. M. Camp (Railway and Engineering Review):—I move that this section be accepted.

President Kittredge:—Is there any discussion on this section? We ought to have some discussion on each one of these points, even if the discussion is all favorable. We would like discussion on both sides, if there is any.

(Motion carried.)

President Kittredge:—The second paragraph, on freight-car repair yard, is open. We will consider that it is not necessary

to make a motion that it be accepted, but will consider that the question of its acceptance is now before the house. The section reads as follows:

**"Freight-Car Repair Yard.**—A repair yard should be composed of short tracks. The spacing of tracks on which light repairs are to be made should be less than that for tracks on which heavy repairs are to be made."

(The section was adopted.)

President Kittredge:—Discussion is now open on the third paragraph, which reads as follows:

**"Passenger Coach and Car-Cleaning Yard.**—The yards should be at such a location as to be of ready and quick access to and from the station. The track should be of such length that they will accommodate trains without cutting. Better results will usually be obtained with stub tracks and the car-cleaners' repair and supply building located at right angles to them at the stub-end of tracks."

Mr. Tratman:—I would say, to start a little discussion, perhaps, that two types of car-cleaning yards are considered—those in which there are parallel tracks connected at one or both ends, with the house at the side of the yard, and those in which there are a series of stub tracks with a building at the end of the stub tracks. The report rather recommends the second type.

(The section was adopted.)

President Kittredge:—Discussion is now open on the fourth paragraph, relating to inbound freight houses. It reads as follows:

**"Inbound Freight Houses.**—This house should be of such width as will furnish a reasonable amount of floor space for the holding of freight. (Fifty feet is a good average width.) Usually not over two tracks are needed. These tracks should be provided with platforms to avoid the necessity of spotting cars."

Is there any discussion on this section?

Mr. Camp:—The Committee says: "Usually not over two tracks are needed." I understand that each track should be provided with a platform. I would ask if they intend that the platform should be built between the first track and the freight house proper, or whether there should be a platform for the

freight house? According to the wording of the report, it should be a platform for each track.

Mr. Tratman:—The plan given shows one platform next to the house and another platform between the tracks. With platforms only between alternate pairs of tracks, the cars would still have to be spotted, so as to get their doors in line to enable the trucks to be run through from platform to platform. With cars and tracks alternating, this would not be so necessary.

Mr. Camp:—It is not necessary to have a platform between the first track and the house to avoid spotting cars. The Louisville & Nashville and the Michigan Central roads are building what they call continuous-door freight houses. The whole side of the freight house is taken up with a series of doors without any posts, and arranged so that one can open the door at any point. No matter where a car is placed, one can open a door in the freight house opposite the door of the car.

Mr. Tratman:—That is not a universal arrangement, and in a great many freight houses they have a series of doors and curtain walls between, and unless there is a platform you have to spot your cars for the doors.

Mr. Camp:—The wording of this paragraph would seem to imply that the Committee thinks it necessary to have a platform next to the house, and there is a form of construction where that is not required. The question is whether that paragraph should be put as strong as it is.

Mr. Hunter McDonald (Nashville, Chattanooga & St. Louis):—I think the point made by Mr. Camp is well taken. I do not think the platform should be next to the freight house. I think there should be two tracks next to the freight house, and the transfer platform beyond. Sometimes it is necessary to put three where you have a crowded place. I have seen in operation during the past year and a half two large freight houses built by the Louisville & Nashville Railroad at Nashville, where the bottom chord of the roof truss is extended 8 feet beyond the posts; in other words, the platform is roofed and the doors are hung from the eave of the roof in such a way that any part of the entire side of the building can be opened up, and there is no obstruction whatever in the way. The result is that no cars have to be spotted on the first track. It is an admirable

arrangement, and is not in keeping with the plan proposed by the Committee, as shown by the diagram. It is a decided improvement over that.

President Kittredge:—I ask Mr. McDonald if setting the posts back 8 feet from the edge of the platform and covering it over is not practically putting a platform on the outside of the building? While under the same roof, it is outside the walls of the building, whether it has doors or a back partition.

Mr. McDonald:—That is true, but this diagram does not make the point plain.

Mr. D. W. Lum (Southern Railway):—It would seem to me that the object is to avoid spotting cars, and if that object is to be accomplished, the platforms should be between the tracks, as indicated on the print.

Mr. J. H. Abbott (Baltimore & Ohio):—The wording of the conclusion seems to me to be very happy, in that it does not specify that you must have a platform, or not a platform. Whether it is one platform, or two platforms, the only point in view is that it shall avoid the spotting of cars. If it requires two platforms, then two should be used; if it requires only one platform, then one is all that is necessary. I think the wording is very well as it is.

Mr. A. S. Markley (Chicago & Eastern Illinois):—I believe there should be a freight platform between the car and the house for the proper handling of freight. No matter what the construction may be, the doors are there and the posts are in the way; and these posts must not be in front of the door, and consequently it will be necessary to place the cars so that the posts do not obstruct the car door. Where we have a platform, no matter where the cars are set, the cars can be loaded at any point from the platform.

Mr. McDonald:—I think the gentleman misunderstands the proposition. The freight house I speak of is 800 feet long, and there is not a post from one end to the other, at the place where the car is discharged into the house. Wherever the car stops, all you have to do is to move the doors and you are ready to go to work. The platform is incorporated in the house, and the supports of the roof are set back 8 feet.

Mr. Markley:—That practically puts the platform between the house and the car, as you suggested a short while ago. It will answer the same purpose as a platform, of course.

Mr. A. W. Swanitz (Chicago Transfer & Clearing Company):—I would like an opinion as to the proper door to use, so as to make a continuous door—what, in the opinion of the members, would be the proper door to select for that house.

President Kittredge:—The question asked by Mr. Swanitz would properly come up under the head of details of construction of buildings, and not in the arrangement of yards and terminals. We are considering the arrangement, primarily, of the tracks, and, of course, the tracks must be taken into consideration, as related to the freight house.

Mr. Tratman:—I would call the attention of the members to a sentence in the second paragraph, on page 11, where it says: "It would not be proper for the Committee to outline the construction of a freight or transfer house, or the manner of building a track." We think it is a matter for the Building Committee to decide as to the construction of the house, while this Committee has to do more particularly with the methods of operation at the house and yard.

President Kittredge:—The Chairman thinks that the position taken by the gentleman in charge of the Committee is entirely proper.

Mr. J. B. Flanders (Cincinnati Northern):—I would like to ask if it is the intention of the Committee to recommend platforms between the tracks?

President Kittredge:—I should think that the wording of the paragraph is such that it should be provided with platforms, so that any number of platforms could be supplied. The diagram to which the Committee has referred shows a platform between the tracks.

(The fourth paragraph was adopted.)

President Kittredge:—We will now consider the fifth paragraph of the conclusions, which reads as follows:

"Outbound Freight House.—In order to decrease trucking at this house it should be of narrow width. (Twenty-five (25) feet is a good average width.) It is of advantage to have a great number of cars at the house, so that all freight can be loaded into

the cars direct. It is not advisable to load through more than four (4) cars. To prevent the necessity of spotting cars, the tracks should be separated by platforms. Where a great number of cars are required, the trucking distance will usually be decreased by having stub tracks running up to the freight house, which is at right angles to them; these tracks to be separated by covered platforms leading to the freight house. In addition to decreasing the trucking distance, this type avoids trucking through cars."

The adoption of this conclusion is now before the meeting.

Mr. Abbott:—I will offer an amendment to this conclusion, that instead of the words, "the tracks should be separated by platform," that the same wording as used in the previous paragraph, viz., "These tracks should be provided with platforms to avoid the necessity of spotting cars," be adopted. I do not altogether like the idea of requiring that platforms should be placed between each of the tracks. It may be desirable to have pairs of tracks without platforms, out-of-doors, or without having each side provided with a platform.

President Kittredge:—The Committee will accept the amendment in the phraseology, so that the paragraph will read the same as the last two lines on page 11.

Mr. W. C. Cushing (Pennsylvania Lines):—I take exception to the statement that 25 feet is a good average width for outbound freight houses. I think it is a minimum width. I think the proper width for outbound freight houses is 30 feet. Twenty-five feet, with the accessories which are necessary to be placed on the platform, makes a crowded platform. I think 30 feet is better, practically, as the proper average width of outbound freight houses, and I make a motion to change it to 30 feet instead of 25 feet.

Mr. McDonald:—Does that mean that the house is 25 feet, or does that include the platform?

Mr. Cushing:—That means the house from wall to wall.

Mr. McDonald:—As I understand it, there is a platform besides that on the outside?

Mr. Cushing:—Not for an outbound house, necessarily, because it is not as necessary to have a platform on the outbound house as on the inbound house, where we have cars to spot. In many cases it is not easy to put platforms outside of the outbound house.

Mr. Markley:—I do not see any difference in outbound or inbound freight houses. The trucking is simply reversed. Instead of the load coming in it goes out, and what will apply to one should apply to the other.

Mr. Cushing:—There is a difference; in the one case you are bringing freight into the house, and in the other case you are backing teams to the freight house and taking it away, and consequently no outside platform is necessary.

Mr. McDonald:—I am speaking of the platform next to the track.

Mr. Cushing:—That depends on the construction of the house.

Mr. McDonald:—It depends on whether the Committee means it shall be a part of the house.

Mr. Cushing:—If it is a separate house it would require a platform next to the cars. If the tracks are inside the house, then we do not need to have it.

Mr. Tratman:—We had a long discussion in the Committee over the question of the width of freight houses. The widths range as high as 60 feet, and over 60 feet, and after a long discussion among the members of the Committee it was decided to recommend 25 feet. I would, therefore, rather that the Association would pass on the question of making it 30 feet than for the Committee to accept the proposed change.

Mr. Cushing:—I have in mind the platform of the new Wisconsin Central freight house in Chicago, which I believe is a 25-foot platform, with elevators in it, and when I looked at the freight house it appeared to be very crowded.

Mr. J. A. Atwood (Pittsburg & Lake Erie):—I would suggest that the width of the house recommended is that of the house proper. The platform between the house and the track would give that much additional width to be used.

Prof. W. D. Taylor (University of Wisconsin):—I move that the parenthetical clause be made to read, "25 or 30 feet."

Mr. D. W. Lum (Southern Railway):—In seconding that motion, it seems to me it ought to be determined just what is the platform and what is the house, before the width is voted on. Mr. McDonald refers to a width which is all platform or all house, as one may consider it—the walls of the building next to

the car, as well as on the street side, being wholly composed of rolling doors. The main posts supporting the trusses are set on a line with the edge of the platform, on the street side, and set back about 8 feet on the car side; so that when the doors on both sides are down there is no outside platform, and when the doors are raised—the door guides on the car side being hinged and drawn up—the whole area is a covered platform.

President Kittredge:—As I understand the matter, there is an amendment that 25 or 30 feet be considered the average width for an outbound freight house.

Mr. A. R. Raymer (Pittsburg & Lake Erie):—I think the Committee has gone to considerable trouble in trying to get away from a practice which is not considered good, and is trying to establish something which will be more nearly the ideal. They make the recommendation that it is an advantage to have a great number of cars at the house, so that all freight can be loaded directly into the cars. That very point makes it possible to cut down the width of the house, and that is the point the Committee wishes to bring before the convention. I shall oppose increasing the width of the house. I am in sympathy with the practice of having the cars properly placed, so that the freight can be put into the cars immediately on receipt, rather than storing it on the platforms.

Mr. McDonald:—I understand this clause and the previous one to mean that if I choose to cover my platform over and make it a part of the house, I can do so, and if the platform should be 8 feet wide, I will have a house 33 feet wide, and with that understanding of the matter, I see no necessity for any change in the clause at all.

President Kittredge:—It occurs to me in taking the average practice of houses that 25 feet is probably too wide rather than not wide enough. If you take all the freight houses in the country, you will find a great many more small houses than large ones. If the matter is measured by the prevailing width of houses at present, I think 25 feet is too wide. If you should measure it by the amount of business done over a platform, probably there would be more business done over one platform in Chicago than there would be over 500 platforms in a town the size of Hazelrigg on the Big Four. It seems to me that the statement of the Committee in this parenthesis is simply a fair statement of facts.

(The amendment proposed by Prof. Taylor was not adopted.)  
President Kittredge:—The sixth clause is as follows:

Roadways.—Where the freight house is on one side and a wall on the other side, the proper minimum width of roadway is thirty (30) feet. Where a freight house is on one side of it and a team track or other freight house is on the other side, the proper minimum width of roadway is forty (40) feet.”

Mr. G. M. Walker, Jr. (Kansas City Belt Railway):—What is meant by the roadway? Is it the clearance from the car, or the rail, or from the center of the track?

Mr. Tratman:—Between the cars.

(The paragraph was adopted, as read.)

Mr. McDonald:—I move the adoption of the report as a whole.

(Motion carried.)

President Kittredge:—The chairman wishes to thank the Committee, in dismissing them, for presenting the report in such a manner that it could be acted on promptly, intelligently and in good order, and begs to call the attention of other committeemen who are present to this report as something after which they could fashion their reports with benefit to the Association.

We will now take up the consideration of the report on Wooden Bridges and Trestles. Mr. McGonagle, the chairman of the Committee, is not present, and we will ask Mr. Lum, the vice-chairman, to present the report, and request other members of the Committee who are present to take seats on the platform.

## REPORT OF COMMITTEE No. VII.—ON WOODEN BRIDGES AND TRESTLES.

*To the Members of the American Railway Engineering and Maintenance-of-Way Association:*

Your Committee No. VII, on Wooden Bridges and Trestles, desire to submit the following report:

It was found to be impracticable to get the members of our Committee together during the year, although several attempts were made to do so. The widely separated localities in which the different members reside and the extreme pressure of business on every railroad have made it practically impossible to take the time to attend a meeting of the full Committee. However, a sub-committee, consisting of Messrs. D. W. Lum,

of the Southern Railway, and I. O. Walker, of the N. C. & St. L. Railway, have put in considerable hard work during the year and have evolved what they call a "Composite Plan" for a pile and framed trestle bridge. A copy of this plan was submitted to each of the members of the Committee, but it did not meet with favor, as it only indicated an *average* practice and not the *best* practice. The plan is herewith submitted to the Association as the work of the sub-committee.

The day is past and gone when a wooden bridge can be considered as a desirable structure on a railroad, and in putting them in we do so with almost an assurance that they will be replaced by a permanent structure within the life of the first timber used in the construction. There are localities, however, where it seems imperative not only to put in a wooden bridge in the original construction, but to maintain it as such permanently. In cases of this kind it seems like true economy to put in the best type of wooden bridges.

The experts differ quite as much in deciding what is the best type of a wooden bridge as they do in determining the best type of a steel structure, and your Committee can only propose for consideration a type that has been proved by experience to be a safe structure and one economical to maintain.

1. *Length of Span.*—Spans to be twelve feet centers for intermediate bents and eleven feet six inches for end bents, thus permitting the use of twenty-four-foot stringers.

2. *Foundation.*—Foundations to be of piling in all cases where possible, and when not possible to put in piling, to use concrete or masonry piers, but never to use mud-sills below the level of extreme high water and not at all unless compelled to do so by circumstances. Piling should be native timber if possible, cut when the sap is down in the winter season and carefully trimmed and peeled. There should be six piles to each bent of pile bridge and an additional number for framed bents of high bridges to make a good foundation for interior batter posts. Piles should be thoroughly driven even to the extreme case, as has been quoted, where an Irish foreman was asked when he considered a pile to be driven, and replied, "When it won't go any more." In other words, use more common sense and less theory in determining when a pile is driven.

3. *Swaybraces.*—Swaybraces should be not less than three by twelve inches in section and of such length as to give the nearest practical angle of forty-five degrees in inclination. It is not necessary to use extremely long braces, quite as good results being obtained by properly lapping the shorter lengths. All swaybraces should be fastened to piles and caps with boat-spikes, three to each intersection, and of a length equal to twice the thickness of the plank plus one inch.

4. *Girts.*—Girts should be not less than eight by ten inches in section, lapped over or under each other at the bents and bolted thoroughly to same. There should be four lines of girts at each separate story extending through to the pile bents at end of structure.

5. *Sash Braces*.—In pile bridges exceeding twenty feet in height, it is recommended that sash braces three by twelve inches in section and doubled be placed one foot above the ground line and also midway between this point and the cap, and thoroughly bolted to each pile. This adds materially to the lateral stiffness of the structure.

6. *Sills*.—Sills should be twelve by twelve inches in section, of White pine, Southern pine or fir timber and fastened to each pile with a drift bolt of one inch diameter and twenty-four inches long with chisel point and no head.

7. *Posts*.—Posts should be twelve by twelve inches in section, of White or Norway pine, Southern pine or fir timber, with two dowels three-quarters of an inch diameter and twelve inches long at the foot of each post.

8. *Caps*.—Caps should be twelve by fourteen inches in section, of White pine, Southern pine or fir timber, sized one side to eleven and three-quarters inches in thickness and fastened to each pile or post with one drift bolt three-quarters of an inch in diameter and twenty-four inches long, with chisel point and no head.

9. *Stringers*.—Stringers should be eight by sixteen inches in section, of Washington fir or long-leaf Southern pine timber and should be a length equal to twice the span and laid with broken joints. There should be three lines under each rail and one line under each guard-rail, and they should be fastened with drift bolts three-quarters of an inch in diameter and twenty-four inches long, with chisel points and no heads. There should be only one drift bolt placed into the cap at each intersection of the group of stringers with cap, and this bolt should be placed in the continuous stick. The outside or jack stringers should be butted together and one drift bolt placed into cap at each end of the butt joint. The stringers in main chord should be packed together with bolts and cast iron packing blocks one and one-eighth inches in thickness. Two packing bolts to each span in each group of stringers.

10. *Ties*.—Ties should be six by eight inches in section and twelve feet long sized one side to five and three-quarters inches and laid uniformly twelve inches center to center. They should be of White Oak timber, if possible, or of White pine or Southern pine, where White Oak is not to be obtained.

11. *Guard-rails*.—Guard-rails should be eight by ten inches in section, fourteen feet long of White pine or Southern pine halved together at joints and joint placed over middle of span. They should be bolted through the tie and outside or jack stringer with machine bolts three-quarters of an inch in diameter and three to each span. Guard-rails should be notched two inches in depth over ties.

12. *End Planks*.—White pine furring strips of two by six inches in section and four feet long should be spiked to the end of main and jack stringers and caps, and upon these there should be fastened four end planks three by twelve inches in section and twelve to eighteen feet long

to take care of the ballast at end of bridge and to permit of a smooth connection between the embankment and the bridge.

The above features are, in the opinion of your Committee, typical for the present loads which our bridges are required to carry. We do not submit a typical plan for the reason that all railroads will continue in the future, as in the past, to design and construct their wooden bridges after the ideas of their own engineering departments, but we submit them as safe and *economical* in the true sense of that word to those who wish to profit by the experience of others, and hope that they may prove of some benefit to our members.

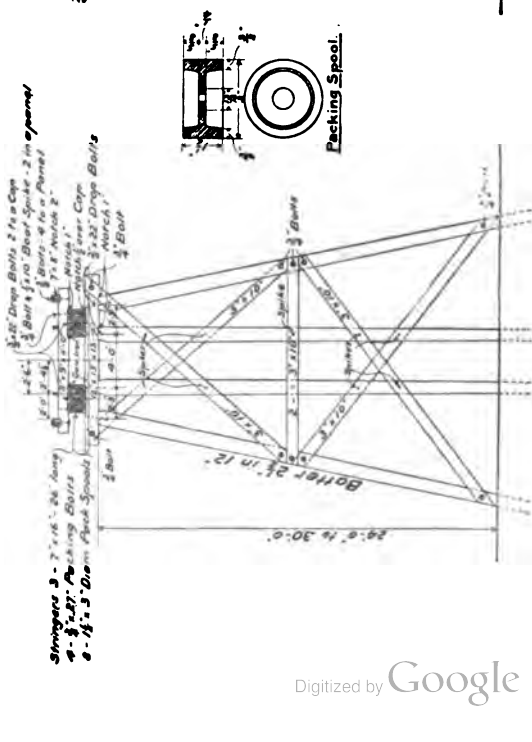
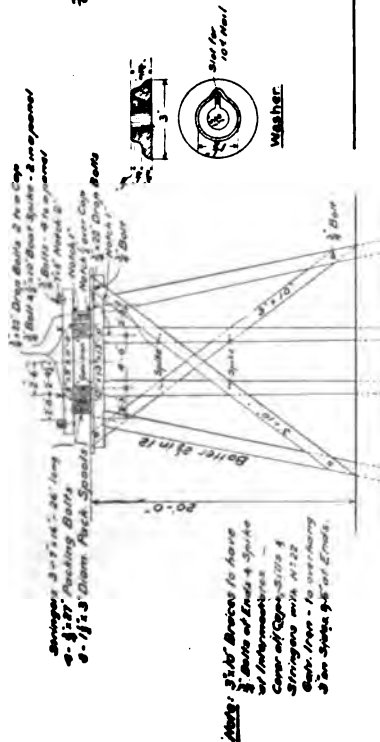
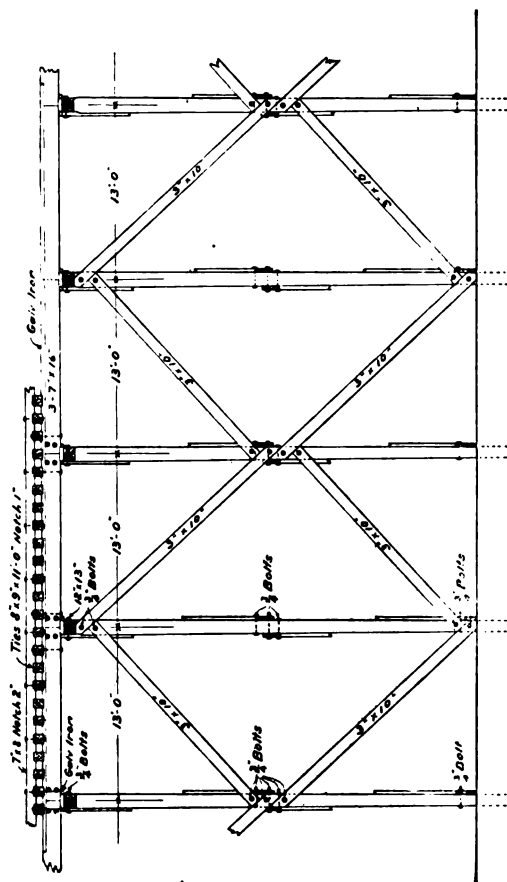
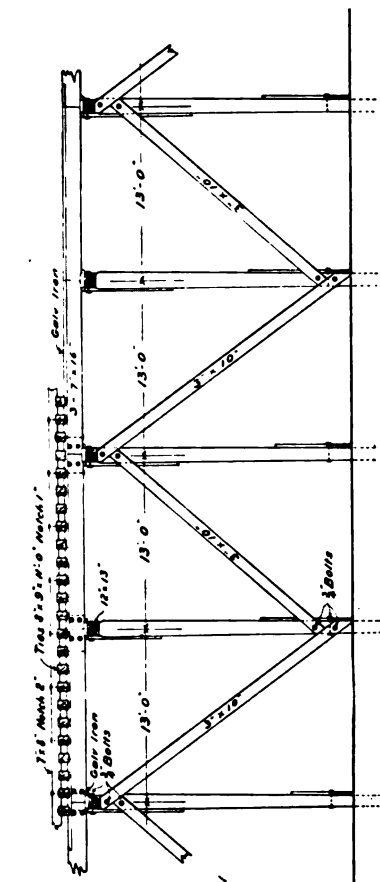
Respectfully submitted,

W. A. MCGONAGLE, D. & I. R. R. R., Duluth, Minn., *Chairman*.

Mr. D. W. Lum (Southern Railway) :—The members of this Committee are located at points rather remote, and have not been able to meet at any time during the year, and several of the members have never met one another. Our chairman has not been able to give the matter the attention that he desired, but very shortly before the convention he forwarded to the Secretary a statement or report, which is here presented. One of the sub-committees obtained from about 35 or 40 railroads blue prints of the standard trestles in use. This sub-committee met at Washington and endeavored to make a composite print from these 35 or 40 standards. Now, with a composite, like a compromise, we are sure of one thing, and that is that it will never be satisfactory to anyone. This composite print is submitted for the Association to act on, to dissect and dismember, and to use, perhaps, as a text for such sermons or instructions as they may wish to give us. We are here to receive these instructions. There is one peculiar thing that you will recognize, and that is that the chairman's report is presented and the report of the sub-committee is also presented, and they differ very materially in many ways, so that you may take your choice. If you do not like one, the other is presented, and you can choose between them.

President Kittredge :—The report of the Committee on Wooden Bridges and Trestles is before you. As this report stands in rather a peculiar position, it might possibly be well for the Association to accept it as a report of progress, and refer it back to the Committee for completion. The report is not in just the form it should be for this Association to act upon any conclusions







in regard to the matter, and the disposition suggested might be a good one.

Mr. W. B. Poland (Baltimore & Ohio Southwestern) :—I move that the report of the Committee on Wooden Bridges and Trestles be accepted and referred back to the Committee for a further report.

Mr. I. O. Walker (Nashville, Chattanooga & St. Louis) :—Just a word in regard to the information furnished the Committee by the various railroads. The sub-committee has received on the pile and trestle work reports from 45 railroads, of which 33 were effective; that is, the other 12 or 13 roads either had no trestles or only one or two, and it was not worth while considering them. That left about 75,000 miles of road reporting, or practically one-third of roads in the United States. The Committee would ask urgently that those roads which have not answered Circular 18 of the Secretary do so as soon as convenient, and the Committee will appreciate it.

Mr. W. C. Cushing (Pennsylvania Lines) :—I would make a suggestion in regard to the future work of the Committee on this subject, and that is, that it is entirely proper to place on their drawing the locomotive diagram from which it is compiled. I do not think it is sufficient to say, as the Committee does, that this may be considered as a good, safe trestle. That hardly means anything to me, because all roads are not using the same weight of engines and cars, and I think it is important that we should know how the stringers were calculated for this; that is, what load. No information is given as to that, and it is always proper to accompany a drawing of this kind with that information.

Mr. Lum :—The stringers are calculated for 100-ton consolidation engine; that is, 45,000 pounds on an axle, which gives about 1,400 pounds per square inch of fiber stress.

Mr. Hunter McDonald (Nashville, Chattanooga & St. Louis) :—I want to call attention to the fact that the text of this report is one thing and the illustration is another. One of them is the report of the Committee, as I understand it, and the other is the report of the sub-committee, and I think we are setting a bad precedent when we accept a report as a report of the Committee when it only comes from one or two members. While I do not think we should be so ungrateful as not to recognize the work

of the members of the Committee, I have no objection to offer other than to say it is a bad precedent to accept a report signed only by the chairman.

Mr. Walker:—I think the criticism made by Mr. McDonald is a good one, and it is no more than justice to the Association that the reason for the report being in this duplex condition should be placed before them. The sub-committee met in Washington and took these 45 plans and made an average plan therefrom, never intending that the Association should see that plan, but intending to use it as a study plan, and distribute it to the members of the Committee for criticism and correction, and finally to adopt in the Committee a standard plan or type which we would submit to the Association. This study is what is before the Association attached to Mr. McGonagle's report. The chairman, for some reason which I do not entirely understand, failed to distribute this study to the members of the Committee in time. Consequently the study did not receive the attention which was expected, and received very little attention until the date of this meeting. I think, as a member of the Committee, that the first motion, that the report be accepted as a report of progress and referred back to the Committee for further work, is entirely correct.

(The motion was carried.)

Mr. J. P. SNOW (Boston & Maine—by letter):—The report deals only with trestles, but refers to them as wooden bridges in such a way that the inference might be drawn that the order of wooden bridges consisted only of the genus trestle. This, of course, was not intended. The very large numbers of wooden truss bridges doing service, and the considerable number now being built in this country, prove their right to be given a place in our literature, and I hope that future reports of our Committee will open up discussions of their good and bad features.

As the report before us concerns only trestles, it is appropriate to confine the discussion to them.

The structure recommended for consideration and described in the twelve numbered paragraphs of the report is evidently designed for very heavy traffic, although the live load is not specified. For ordinary service much less expensive structures are admissible, and the following is submitted as representing the writer's practice:

Spans of 15-foot centers for intermediate bents and 14 feet for end bents. Thirty-foot timber of the kinds named by the Committee is easily procurable for stringers.

Four piles per bent will answer for low trestles, where there is no current of water to cause ice or drift to crowd them. Six or more should be used where ice is a factor.

Sway braces should be used for heights of 12 feet or over, but for heights less than 12 feet, if on tangent and not subject to ice, no braces are needed.

Longitudinal girts, 4x12 inches, disposed as called for in the report, should be used where bracing is more than one story high.

Sash braces are hardly needed at the ground line, but should be used at the division of stories of sway bracing.

Caps for pile bents should preferably be "girder and rider;" that is, the piles should be boxed into on each side, leaving a tenon 4 or 5 inches thick and two 7x14-inch sticks bolted on with screw bolts and a 4x16-inch laid on top and spiked to the girders. This is more expensive to put on than a solid cap, but it adds very much to the stiffness of the bent and holds the piles securely in line. If a bent is capped as recommended in the report, the piles are very frequently split, hauled out from under the cap or the drift bolt bent by the pile springing out of line. This trouble is, of course, more serious with low bents than with high ones. The 4x16-inch rider cap serves a double purpose. It protects the pile tenons from the weather, and it requires the bents to be capped so much below the stringers that in renewals the work can be done without disturbing the old structure.

Stringers should be two 10x16-inch under each rail and one 8x16-inch outside, 10 feet out to out. All should be in 30-foot lengths, and the two main sticks should be spaced 2 inches apart with c. i. spool separators between. The joints should be broken and one  $\frac{3}{4}$ -inch packing bolt with separator used at each end of each stick. Each end of each side stringer and the middle of each main stringer stick should be drift-bolted to the cap with a  $\frac{3}{4}$ -inch drift, 22 inches long, these bolts to be so placed that they will go into the girder cap. The objection to three sticks per rail is that for a given line of stringer one cap will have one stick continuous over it and the next will have two, and so on. The continuity of the sticks adds something to their effective strength

and stiffness, and it is desirable to have this feature uniform. The above sizes are based on a fiber strain of 1,200 pounds per inch in the stringers, after allowing what is deemed safe for the continuity and providing for a deviation of about 6 inches in the length of the spans as driven from that laid out.

Ties should be 6x8 inches by 12 feet, planed one side to even thickness and laid flatwise 14 inches on centers. Long leaf Southern pine is preferred as being more durable than oak or chestnut. Lining spikes should be driven in each side stringer through the same tie, about 6 to 8 feet apart. If the track gets slightly out of line, these spikes can be drawn and the track lined up.

Tie spacers should be 6x8 inches, in any length, with butts halved on ties and secured every fourth tie with a 9x $\frac{3}{4}$ -inch lag screw and round commercial washer. They should be dapped 1 inch, leaving them 5 inches above the tie, and should be slightly beveled, say  $\frac{3}{4}$  inch wide, on both corners. They should be placed flush with ends of ties.

Guard rails should preferably be of same size as main rails and placed inside of same, so there shall be at least 8 inches clear between heads of main and guard rails; 9 inches is better. They should be brought together at points at least 30 feet from the ends of the trestle and finished with an old frog point or special casting.

The above structure is designed for a live load of 6,880 pounds per foot of track, or engines with 45,000 pounds per axle, 8 feet apart, and fiber strain of 1,200 in the stringers. The span is taken as 15 feet 6 inches, to allow for the impossibility of getting the bents driven exactly where laid out. The ties are considered to distribute the load so that 85 per cent of it is carried by the main stringers, and the continuity of the stringer sticks is supposed to reduce the moment about one-eighth part.

Fourteen-inch spacing of ties is preferred to that given in the report, as it is just as safe and the cog on the tie spacer is 50 per cent stronger than if the spacing is 12 inches. Where 4-inch cogs are used it is frequently the case that several contiguous ones will split off, leaving the ties liable to bunch. A derailed wheel will pass as safely over ties spaced 6 inches in the clear as if only 4 inches. Another objection to 4-inch spacing is that it

just lets a man's boot through and it is sometimes difficult to get it out again. A case occurred in the writer's experience where a man lost his leg by being caught in this way.

The report does not specify the distance out for the guard timber. It should be flush with ends of ties. If set in, as is frequently advocated, the ties may as well be shortened and save the timber. In double track trestles the ties should be butted on a middle stringer and a 6x12-inch used for spacer. Ties long enough for both tracks are not desirable, on account of trouble in renewing. The true office of the so-called guard timber is to space the ties. It is very inefficient as a guard. Inside rails are prescribed by law in some states, and are by far the best guards available.

One design of trestle is not applicable to all railroads and conditions, of course. For heavier loads than that mentioned above, larger timber is required, but if the basis there specified is followed there need be no fear of lack of strength. It is not essential to design timber trestles for so large a prospective increase of loading as should be provided for in metal structures. Their life is but about fourteen years in the climate of New England, hence provision for usefulness in the distant future is unnecessary.

President Kittredge:—The next report is that on Masonry. Mr. H. G. Kelley, of the Minneapolis & St. Louis Railway, the vice-chairman of the Committee, will present the report.

#### REPORT OF COMMITTEE No. VIII.—ON MASONRY.

*To the Members of the American Railway Engineering and Maintenance-of-Way Association:*

The Committee on Masonry, in continuing its work for the past year, has considered that some detailed consideration of classification of the different kinds of masonry might be of practical value to the members, and might possibly lead, in a measure, to uniformity of practice, so far as such uniformity is possible and desirable. To that end standard specifications and other data, in regard to their practice and customs as to masonry construction, have been obtained from nearly seventy of the railroads of the United States, Canada and Mexico. Of this number, fifty roads may be classed as of some considerable extent and experience, and the remainder also as of value in showing conditions that obtain on smaller roads. Not that size of a railroad necessarily makes its practice in ma-

sonry construction, or in other matters, something to be unquestionably approved and followed, but amount, extent, and varying conditions to be met naturally bring up more difficulties to be provided for than would be found on a shorter line.

A review, however, of the best specifications seems to show a rather surprising substantial agreement in numerous main points. As to stone masonry, for instance, some roads name coping and bridge-seat masonry and then classes 1, 2 and 3 for what may be termed the body of the work; others name classes 1, 2, 3 and 4; and still others, while not stating classes by numbers, yet, under some nomenclature, have virtually these three or four classes. It seems feasible to have substantial agreement on some classification that can be made to apply to general practice throughout the country. In doing this it is not anticipated by the Committee that they will be able to present, on first trial, a complete specification that will meet with approval of all parties. It is conceivable, however, that an outline may be made that will differ but little from the best practice, and that can, by minor amendments, be easily made to include the particular specialties that any road may think desirable for their conditions.

The basis of such an outline is presented further on in this report, with the hope that if the general idea of uniformity is considered desirable and feasible, that the criticisms of the members may help to bring it into practical shape.

One feature has been forcibly brought to the attention of the Committee, by responses from several first-class roads. This is perhaps best indicated by a quotation from one communication from an important first-class railroad: "All our masonry is built by our own men, and we have no printed specifications, as the foremen understand how the work should be done."

Almost the same language is used in responses from Chief Engineers of several other roads. It is not this Committee's province or desire to take issue with this, in many respects most excellent practice; but even with such practice, it might be found worth while to have a general printed description of what is considered requisite for good work. The outline that the Committee ventures to present might perhaps be better termed a "Description" of several classes of masonry, rather than a formal "Specification." It would be something that, with a few additional requirements printed on accompanying sheets to show what other special conditions, if any, are to be exacted from a contractor, would then constitute a complete specification, and could be made part of a contract. One point of objection that is found in several good specifications for masonry is that, along with the outline and kind and quality of work that is wanted, various provisions not in themselves descriptive of the masonry are included, such as a clause that "the presence of the engineer or inspector shall not release in any degree the responsibility of the contractor;" or, "that no conventional measurement will be allowed, any rule or custom of the country to the contrary notwithstanding." Such provisions,

while entirely right and proper, in many cases are not, it would seem, any part of a "description" of masonry, which is, perhaps, after all, pretty nearly what "Specifications for Masonry" should be.

Some of the best roads seem to appreciate the force of this, and their specifications for masonry are strictly descriptions of the materials to be used and the manner of using them, the same being entirely impersonal and as readily applicable to work done by their own men as by outside contractors.

The necessary proper restrictions as to contract work can easily be given on a separate sheet and with increased force and clearness, from the very fact that they are separately stated.

Before giving a suggestion for description of the several classes of stone masonry, a general definition of masonry is submitted, as follows:

"Masonry, in its widest sense, includes all constructions of stone or kindred substitute materials, in which the separate pieces are either placed together, with or without cementing material to join them, or, when not separately placed, are encased in a matrix of firmly cementing material."

This definition is intended to cover everything properly classable as masonry. Of course, the better the materials and workmanship, the better and more permanent the resulting structure, and the best and most substantial masonry can be made to approximate in permanency works of nature.

From work of such character the scale of quality may be graded down, until the poorest masonry may be inferior, in point of durability, to the most ordinary wood construction, yet the inferior structure of stone or kindred materials is masonry, nevertheless. Besides the general gradation of masonry, as to quality, there are various special subdivisions to be noted, all, of course, still subject in their own class to the range of quality from good to bad. For reasonable clearness, masonry should usually be named under the proper one of such subdivisions. Some of these may be named as follows:

Stone masonry, with numerous possible qualifying descriptive terms and variations;

Brick masonry;

Concrete masonry.

These three subdivisions may perhaps at present time be construed to cover nearly, if not quite all, masonry; the terms "stone" and "brick" being understood to include the most inferior as well as the highest class of these materials, and concrete masonry covering work made up from combinations of either or both of these materials, with a proper cementing matrix. It may be of no little value for this Association to give the authority of its approval to a sound and comprehensive definition of what constitutes masonry.

After offering for criticism a definition for masonry, the Committee further presents a suggestion for some particular descriptions hereinbefore referred to, in the hope that it may do something to harmonize

good railroad practice in usual masonry construction. Of course, the best "description" or "specification" will not insure good work, if construed or carried out by incompetent, careless or dishonest agents, but is yet of much value, even with unsatisfactory agents; and, under usual conditions, will go far towards securing good, strong work at reasonable cost. The attempt is made to furnish enough of an outline to constitute a good, common nucleus, to which different parties may add other particulars descriptive of the peculiarities of their various situations. The outline here given might be printed on two leaves of usual contract form, leaving sufficient blank space at end of each class description for such special amendment as might be desired.

### DESCRIPTION OF STONE MASONRY.

All stones used for masonry shall be sound, durable, well seasoned, from sources approved by the engineer, and shall be laid on their natural beds.

*Mortar*, for laying up stone masonry, unless otherwise expressly stated, shall consist as follows: Either one part of approved Portland cement to three parts of good, sharp sand, or one part of approved natural cement to two parts good, sharp sand, all to be very carefully measured and mixed, and to be used always before it shall have commenced to set.

*Mortar*, for pointing, shall consist of one part Portland cement to one or two parts of sand.

(Space for additions.)

*Finished copings, parapets, bridge-seats, and other finely dressed special stones.*—Work that comes under this head shall be of selected stone, of the best quality, free from defects, shall be very accurately cut, being finely bush-hammered where called for, and as per plan and dimensions given. To be laid to  $\frac{3}{8}$ -inch joints.

(Space for additions.)

*First-class Masonry.*—First-class masonry will be laid in Portland cement mortar, in regular courses, each stone being carefully cleaned and dampened, if desirable, before setting. The face stones shall be rock-faced, with edges pitched to a straight line, and no projections exceeding three inches. A draft line, two inches wide, shall be cut at each angle in the masonry. The beds throughout and the joints for 12 inches back from the face shall be dressed to lay to  $\frac{1}{2}$ -inch joints. No course shall be less than 12 nor more than 30 inches in thickness, and, except the coping, and the thickness of any course shall not exceed the course below it. Stretchers shall not be less than 3 feet long, and not less than 18 inches wide, nor less in average width than  $1\frac{1}{4}$  times its height, and at no single place less in width than height.

*Headers* must not be less than 4 feet long, where the wall is of sufficient thickness, and the majority shall exceed that length. Where the wall is not over 5 feet thick, they shall extend entirely through the wall. Headers will extend at least 20 inches beyond the width of the adjacent stretchers. The usual arrangement shall consist of headers and stretchers, alternately arranged, so as to thoroughly bond together the face stones and the backing; for rare exceptions, two stretchers will be allowed to one header, by special permission, to cover each such case. The stones of each course of the face must break joints at least one foot

with those of the course below. No hammering will be allowed on any stone after it is set. Each stone must be set upon a full bed of fresh mortar, the broadest bed down, and brought to a firm and level bearing without spalls or pinner.

*Backing.*—The backing shall consist of large-sized, well-shaped stones laid in full mortar beds and breaking joints so as to thoroughly bond the work together. The spaces between the larger stones shall not be over six inches in width and shall be thoroughly filled with small stones and spalls laid flat, and all spaces flushed full with mortar. The courses shall correspond with the face stone, but may be made up in part by two thicknesses, providing no stone less than 8 inches thick be used. In cases approved by the engineer, satisfactory Portland cement concrete may be used for backing.

*Second-class Masonry.*—Second-class masonry shall be laid in cement mortar. The face stones shall be rock-faced, no projections over 3 inches, edges pitched to a straight line, shall have parallel beds and rectangular joints. The beds and joints for 8 inches back from face shall be dressed to lay not over  $\frac{3}{4}$ -inch joint. The stones need not be laid up in regular course, but shall be laid level on their natural beds, shall be well bonded, having at least one header 3 feet 6 inches long to every three stretchers with joints well broken; no stone shall be less than 8 inches thick, and no stone shall measure in its least horizontal dimensions less than 12 inches, nor less than its thickness.

*Backing.*—The backing shall consist of well-shaped stones, not less than 6 inches thick, and of which at least one-half shall measure 3 cubic feet, to be laid in full mortar beds, with joints well broken, well bonded together, and with the face stone. All spaces to be thoroughly filled with small stones and cement mortar.

*Third-class Masonry.*—Third-class masonry shall be laid dry or in mortar, according to the direction of the engineer. It shall consist of good quarry stone, laid upon the natural beds, and roughly squared, on joints, beds and faces, the stones breaking joints at least 6 inches; the wall shall be bound together by headers, occupying one-fifth of the area of the face of the wall front and rear, and extending through walls 3 feet or less in thickness; no stone shall be used in the face of the wall less than 6 inches thick or less than 12 inches on the least horizontal dimensions.

*Concrete Masonry.*—Cement concrete may be described as formed of broken stone or brick, gravel or kindred materials, cement and sand. A combination of the best materials, in the best proportions, and with the greatest care and thoroughness of preparation, placing and protection until thoroughly set, will result in the best possible work—work that, judging from past and recent experience, may be considered nearly, if not quite, the equal to the best stone masonry in respect to stability and durability. In proportion as any of the constituent parts are of inferior quality, or the workmanship and care deteriorates, the resultant will be of inferior quality as to appearance, strength or durability.

Fortunately, however, in the use of cement concrete, for the many and diverse purposes and places for which it is proper and often superior to other materials, no such extreme theoretical assurances of its complete and minute integrity are required.

Experience, especially of recent years, has so far advanced our knowledge and justified confidence in the substantial integrity and ample security

of good cement structures, well designed for their situation, that no one need hesitate to use it in important work, a reasonably close approach to the theoretical requirements for the "best concrete" being entirely practical to obtain with means available in most situations.

The adoption of concrete for the whole or part of any structure should be done with judgment as to its appropriateness for the service required, avoiding the extreme of placing concrete where stone masonry is evidently better for the purpose, all things considered; as well as the other extreme of failing to use it where its adaptability is conspicuous.

Judicious combinations of two kinds of work can sometimes be advantageously made; a granite face, with concrete backing, being often a good combination; likewise, a brick facing, with concrete backing, may in some cases be a desirable arrangement. In any such combinations, care should be taken to have strong mechanical bonding between face and backing, as well as good cement adhesion.

In the formation of cement concrete, of course, the quality of the cement is of prime importance, as, with poor cement, strong work is impossible, however excellent all other ingredients and however thorough and faithful the work. This naturally leads to the consideration of what are proper requirements for different kinds of cement and what are proper methods of ascertaining whether such requirements are carried out.

A report on qualities of cements and tests to ascertain the same might be a very lengthy one, and still be only an abstract from able reports already published on these subjects. It will be considered sufficient for the practical consideration of this Association to state in a few words what should be the minimum requirements for natural, hydraulic, and also for Portland cement, to permit their use in respectively proper parts of usual railroad cement concrete structures.

Similarly, a few words tells what may be generally accepted as requirements about quality of stone and sand to enable good, strong work to be produced.

After that, thorough mixing, compact placing, and proper temporary protection, when necessary, covers perhaps all the fundamental principles of good cement concrete making.

A detailed specification is but a more or less elaborate statement of the above points. The following outline herein attempted is meant to cover only such points as there seems to be some hope to get reasonable agreement on, leaving further necessary elaboration to individual ideas:

#### OUTLINE SPECIFICATION FOR CEMENT CONCRETE.

**Cement.**—Natural hydraulic cements used shall be freshly made, of uniform quality, so ground that 75 per cent will pass through a sieve with 10,000 meshes per square inch, shall have a tensile strength on one square inch section of not less than 100 pounds at age of 7 days—1 day in air and 6 days in water—and not less than 160 pounds per square inch at age of 28 days.

When mixed with equal parts of good, sharp sand, shall have a strength of not less than 80 pounds per square inch at age of 7 days—1

day in air and 6 days in water—and not less than 140 pounds per square inch at age of 28 days.

Portland cements used shall be of uniform quality, so ground that 90 per cent shall pass through a sieve with 10,000 meshes per square inch, shall have a neat tensile strength on one square inch section of not less than 350 pounds at age of 7 days—1 day in air and 6 days in water—and not less than 500 pounds per square inch at age of 28 days.

When mixed with three parts of good, sharp sand, shall have a strength of not less than 160 pounds per square inch at age of 7 days—1 day in air and 6 days in water.

Cement shall be subject to such additional test requirements as may be especially called for.

*Proportions.*—Cement and Sand: For natural hydraulic cements, the proportion of cement to sand shall not be greater than 1 to 1, nor less than 1 of cement to 2 of sand.

For Portland cements, the proportion of cement to sand shall not be greater than 1 of cement to 2 of sand, nor less than 1 of cement to 5 of sand.

*Broken stone* to pass through 2-inch ring, screened gravel or substitute materials—no more of this material shall be used than can be effectually covered and united together by the cementing mortar. It shall generally be moistened before being combined with the other ingredients.

*Water.*—Sufficient water shall generally be used to make a moderately wet concrete.

The above statements as to proportions are intended for work in the open air and during moderate weather, and such proportions may be varied for conditions of use under water or in freezing weather, the modifications in such cases consisting mainly of using a larger proportion of cement and a less proportion of water than would be used under conditions first stated.

*Mixing.*—A standard for mixing of the various materials is as follows: Mixing cement concrete by hand labor:—The proper amount of sand shall be spread out evenly on a smooth, tight platform; then add the proper amount of cement, and thoroughly mix the two until the mass is of an even color; this amount of mixing should be equal to four times turning over with a shovel; then add a proper amount of water for the conditions of the work in hand and mix thoroughly again until a good plastic mortar is formed; then add the proper amount of broken stone or clean gravel stones, and again thoroughly mix the mass until the stones are covered with the mortar and all voids completely filled; the amount of mixing for this part of the work should be equal to four times turning over with a shovel.

Cement concrete may also be mixed by well-made mixing machines. Machines will be preferred which permit, first, the dry mixing of the cement and sand, then the addition of the water and stone; also such machines or arrangements as conveniently permit the indefinite continuance or repetition of the mixing process will be preferred to those that have a fixed limit for the amount of mixing they can conveniently give to a given charge or amount of concrete.

Whether in mixing by hand labor or by machines, great care should be taken to keep the mixture entirely free from all foreign substances, like paper, chips, rags, sticks, etc.

A concise statement of the intent of the above limitations for cement concrete may be made something as follows: Using cements that are in quality not any below, but rather above, the average of the good brands

in the market, reliable cement concretes may be used with confidence under appropriate conditions, composed as follows: For natural hydraulic cement concrete a good mixture of 1 part natural hydraulic cement, 1 part good sand, and 2 parts broken stone may be considered as good, strong concrete, as practically can be made with natural cement. One part natural cement, 2 parts sand, and 4 to  $4\frac{1}{2}$  parts broken stone may be considered as poor and weak concrete as practically should be made with natural cement, to be used in any work to be classed as durable and sufficient for loads usually placed upon masonry of ordinary dimensions.

For Portland cement concrete a good mixture of 1 part Portland cement, 2 parts good sand and 4 parts broken stone may be considered as good, strong concrete as practically need to be used for any piece of Portland cement concrete of appreciable bulk.

A good mixture of 1 part Portland cement, 3 parts sand, and 6 parts broken stone may be considered as giving a concrete of sufficient strength, when of proper dimensions, for any ordinary masonry construction, and, at many times and places, ample for very heavy work.

A good mixture of 1 part Portland cement, 4 parts good sand, and 8 parts broken stone may be considered as giving a concrete of sufficient strength, when of proper dimensions, for much ordinary, plain work in favorable positions.

With any of these Portland cement concretes there may be judiciously used, on their exposed faces, a "skin" or facing of rich Portland cement mortar, about  $1\frac{1}{2}$  inch thick, to be built up at the same time as the concrete backing, and both tamped well together. This facing should not be too rich in cement, not richer than 1 part cement to 2 parts sand.

In some instances Portland cement concrete has been used in railroad structures, made by mixing the cement direct with certain gravels, as found in favorable banks, without screening to separate the sand and pebbles. It is not thought that such practice could be indorsed for frequent use, or as safe to follow, except with unusually favorable materials, and by individuals whose extensive personal experience might warrant them in it.

The range of proportions previously given in this outline may possibly be as great as might at times be found in some favorable natural gravel banks, but, if the sand and pebbles are separated by screenings and then united with the cement in ascertained proportions, assurance can be felt that the desired strength of concrete, not too rich or too weak, is being obtained.

There is some difference of opinion among engineers as to the advantages, respectively, of broken stone or natural rounded pebbles for use in concrete. Both are used, and much good work is done with both of them. For the very best work good, crushed trap rock or hard limestone will probably give somewhat stronger work with same quantities of cement than the natural rounded pebbles, especially for tests under one year in age.

## COST OF CONCRETE.

It is very difficult to give any general statement that shall be of value as to cost of concrete masonry work.

Referring to railroad structures of Portland cement concrete, such as abutments, culverts, arches up to 30-foot span, of varying proportions in the concrete mixture, and in widely different situations, the cost per cubic yard for good work that has stood up to its requirements has been variously reported at from somewhat less than five dollars up to about ten dollars. In most of these situations the stone masonry that would have been considered right for the same place would have cost from 20 to 80 per cent more money.

If the structures are considered of equal value, the smaller saving may be well worth making, and the larger saving might many times help to determine the question as to whether a timber structure in bad order should again be renewed with timber or be replaced with something more permanent, upheld by concrete masonry.

An accurate account of cost is given herewith as a sample of good work recently done near Pittsburg, Pa., which is of interest:

**REPORT OF CONSTRUCTION OF ARCH BUILT UNDER TRAFFIC, APRIL TO JUNE, 1901, NEAR PITTSBURG, PA.**

Semicircular arch, span, 26 ft.  
Length of barrel, 62 ft.  
Length of east wings, 22 ft.  
Length of west wings, 21 ft.  
Length of retaining wall returns at end of west wings, 39 ft.  
Wing copings, 18 inches thick and sloped.  
Other copings, 18 inches thick and horizontal.  
Top parapet copings above intrados of arch, 5 ft. 6 in.  
Average height of bench walls, 10 ft.  
Thickness of bench walls at spring line, 7 ft.  
Thickness of arch at crown, 26 in.  
Height of haunch above spring line, 7 ft.

Up to present time (Feb. 6, 1902) the general condition of the structure is perfectly satisfactory, there being no signs of weakness or indication of bad weathering. In massive masonry, the engineer in charge thinks general dimensions may be somewhat reduced, as compared with those used in ordinary first or second class stone masonry for railroad purposes where it is proposed to build of Portland cement concrete.

In the concrete, Atlas American Portland cement was used throughout, with river gravel and sand. Two proportions were used, the weaker in foundations and backings, and the other in all face work and in the 26-inch ring work. One part cement, 2 parts sand, 10 parts gravel formed the weaker mixture. In the other we added one-half part cement. We secured our gravel in two sizes or grades, and the intention was to use 8 parts of the coarser and 2 parts of the finer. The finer grade contained no pebbles exceeding one inch in diameter and was secured by passing the gravel from the dredging machine over a screen. However, while this operation excluded all pebbles exceeding the size mentioned, it allowed a very considerable amount of sand and fine gravel to go along

with the coarse gravel in the so-called coarse grade. This necessitated a corresponding variation in our concrete mixtures as to the proportions of the two grades of gravel. The proportion (2 to 8) was determined by treating both grades for voids. In building up the work, which was carried on in horizontal layers of 8 inches, a little mortar (1 part cement to 2 parts sand) was first placed against the face of the form, then the richer concrete mixture to a width of 12 or 15 inches, and the other mixture back of that. Then all was thoroughly (not heavily) tamped together. In forming the ring, the entire 26 inches was made of the richer mixture and the courses inclined approximately to the line of the radius, until an inclination of 45 to 50 degrees was reached. This last inclination was then carried uniformly about to the top and finished somewhat as with a key built up in horizontal layers. The haunching was carried up with the ring, being formed with the weaker mixture. Horizontal and slope copings were made also of the richer mixture.

For lagging and all face work single surfaced and sized hemlock boards, 6 inches wide, were used, generally two boards thick. The face boards next to the concrete were put in place only just ahead of the concrete, in order to diminish as much as possible the effect of cracks and joints on the face of the finished concrete, due to shrinkage of the lumber.

An expansion or temperature joint was put in each wing 4 feet from the face of the arch. In another case the engineer would avoid this, if possible, and locate these joints within the limits of the arch itself, making them somewhat less conspicuous.

After the forms were all removed the exposed surfaces were covered with a very thin grout, applied with a brush, like whitewash. This filled all the minute openings, and still did not produce a surface that would scale off. It was found that a rich grout did not do so well as one made of 1 part cement and 2 parts sand.

The finished structure contained 1,493 cubic yards of concrete masonry, total cost of which was \$7,243.24.

The cost per cubic yard concrete for material and labor was as follows:

#### Material.

Coarse gravel, at 19 cents per ton, 1.03 tons.....	\$0.19½
Fine gravel, at 21 cents per ton, .40 ton.....	.08½
Sand, at 36 cents per ton, .32 ton.....	.11½
Cement, at \$1.60 per barrel.....	1.53½
Lumber .....	.43
Tools and other storehouse accounts.....	.07%
	<hr/> \$2.43¾

#### Labor.

Preparing site and cleaning up after completion of structure, at 15.5 cents per hour.....	\$0.21
Forms, at 23 cents per hour.....	.28
Platforms and buildings, at 23 cents per hour.....	.05
Changing trestle, including service of work train and steam derrick car .....	.08½
Excavation, foundations, at 15.5 cents per hour.....	.31
Handling material, at 15.5 cents per hour.....	.03¾
Mixing and laying on concrete, at 15.5 cents per hour.....	1.44
	<hr/> 2.41¼

Total cost per cubic yard of concrete..... \$4.85

Wages paid were as follows: Foreman mason in general charge, 40 cents per hour; laborers, 15 cents per hour; foreman, 25 cents per hour; carpenters, 22.5-25 cents.

Referring to the above cost, perhaps it should be said that the general conditions were probably as favorable as any likely to be found. The gravel and sand was delivered from hopper cars into bins under each end of the trestle on ground high enough so that practically no material of any kind had to be lifted during its progress from the cars to its final position in the work.

The mixing was done by hand on platforms about 16 by 24 feet, and mixtures averaging  $\frac{3}{4}$  cubic yard were usually made.

The work was begun April 1, 1901. Centers were erected May 1 and 2. The arch was closed May 16 and centers struck May 30, but not removed until about June 18. Filling over the completed arch was begun June 10 and completed on June 22. Trestle stringers were removed and track adjusted on new embankment July 8. No settlement whatever could be detected in the arch either before or after the removal of the centers.

A treatise on "Railroad Concrete Masonry," by Mr. W. A. Rogers, formerly of the Chicago, Milwaukee & St. Paul Railway, is, with his kind permission, annexed hereto as a valuable contribution to the literature on this subject. While the author would probably be the last person to expect or desire complete agreement with his expressed views, and would also be prepared to adopt improved methods in regard to concrete construction, this paper presents the subject of railroad concrete masonry in a thoroughly practical manner, giving data and practice that if faithfully followed can be trusted to give reliable work. (Article appeared in Railroad Gazette, Nos. 24, 27 and 30.) Other discussions on the subject may have been prepared with equally valuable information, but none more complete have been brought to the attention of the Committee. (See Appendix.)

A copy of report on compression tests of concrete cubes for the city of Cleveland, O., is given as of interest and value. (See Appendix.)

The subject of combination of metal beams or rods or metal shapes of various kinds is susceptible of so many variations that its special consideration is not now attempted. While of much consequence, it may be considered, perhaps, as an important detail method of use of concrete, the present consideration being to determine what is fundamentally necessary to secure good, reliable concrete.

A review of the foregoing outlines descriptive of stone masonry and of cement concrete will disclose two different points of view: In treating stone masonry, the description given is substantially a compromise (and with very little, in fact, to compromise) of the present practice of a number of first-class roads. This was easily feasible from their substantial agreement in essentials.

With regard to cement concrete, on the other hand, instead of attempting to find a definite "middle ground" for agreement as to certain special mixtures, an attempt has been made to give a "range" of limitations, not too wide to be useless, but still one within which reliable work will result if fair judgment is used as to the special application.

A little later it may be feasible to give closer restrictions for cement concrete for various special purposes and conditions. It is, of course, too

much to attempt here to give any practical detail guide as to proper dimensions for usual railroad structures when built of good, strong Portland cement concrete; but it may perhaps be fairly said that dimensions that would usually be reckoned ample for second-class stone masonry may be considered sufficient for good Portland cement concrete.

With regard to arches, say from 10 feet to 30 feet span, depending somewhat upon rise of arch, character of loading, etc., dimensions that would be called ample for first-class brick masonry, may be considered sufficient for good Portland cement concrete.

For a very approximate statement, it may be said that for such arches supporting a standard roadbed, of simple Portland cement concrete, not reinforced with metal or otherwise, a thickness or arch ring from 1 inch to 1½ inches per foot of span is sufficient—a minimum of 12 inches being recommended. Instances of good work can be found where the limit of 1 inch is reduced perhaps 10 per cent. It is not thought wise, however, to recommend proportioning railroad concrete masonry construction to the minimum allowable limit, but rather to recommend an appreciable surplus of strength that shall allow well for possible unseen deficiencies as well as for deterioration by action of the elements.

### CONCLUSIONS.

Your Committee begs to submit the following conclusions for adoption by the Association:

*Resolved*, That the following definition be adopted by this Association as a comprehensive definition to cover any kind of masonry, and with the further recommendation that in usual practice the word "masonry" be qualified by some proper term to more particularly describe the kind of masonry under consideration:

Masonry, in its widest sense, includes all constructions of stone or kindred substitute materials, in which the separate pieces are either placed together, with or without cementing material to join them; or, when not separately placed, are encased in a matrix of firmly cementing material.

*Resolved*, That this Association recommends as good practice that railroad companies prepare and use specifications complete in themselves for all kinds of masonry, to be in such form that they may be attached to and form part of specifications and contracts for other railroad construction when desirable.

Respectfully submitted,

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*Committee.*

APPENDIX TO REPORT OF COMMITTEE ON  
MASONRY.

## RAILROAD CONCRETE MASONRY.

By W. A. ROGERS.

The necessity of practicing the strictest economy has led engineers of Western railroads to seek carefully methods and materials which lessen the cost of constructing and maintaining the structures and roadbeds of these lines. The bridges and culverts were originally built largely of timber, and, as a rule, only the very largest bridges were of iron. As these lines have become more important, the temporary structures have been renewed with more permanent ones of iron, steel and masonry, but until within the last few years, in this reconstruction with permanent work, stone masonry has almost invariably been used; brick has occasionally taken its place in arch and other culvert work. The use of stone in the various forms of masonry has had many drawbacks, among which are the difficulty of getting a good, durable stone within a reasonable distance of the work, the practical necessity of using derricks for setting stone of the larger dimensions, with the incident obstruction of traffic while the boom is swung across the track, the difficulty of finding the necessary skilled labor during certain times, notably when building trades are active, thus making the expansion of the masonry force difficult, and last, but not least, the greater cost, especially of first-class stone masonry. In addition to these disadvantages accompanying the use of stone masonry, the increasing difficulty of procuring suitable timber and piles for wooden bridges emphasized the desirability of renewing each year as much as possible of the temporary work with permanent structures.

These conditions have led railroad engineers to the study of concrete as a form of masonry for railroad structures, as it seemed to possess many advantages over stone as a form of masonry, provided it had the quality of durability, and its use in footings has been the growing practice for a number of years. From this small start, its use, first in unimportant structures, such as small culverts and low bridge abutments, has increased until it has been adopted for all classes of ordinary bridge and culvert construction by a number of the important lines of the Middle West.

Concrete construction is yet in its infancy and its qualities are necessarily imperfectly understood, and practice differs materially in minor details. Mistakes will undoubtedly be made on account of a misconception of characteristics, but as these are better known errors will be fewer. In the following, the qualities of this material will be described as the writer understands them and the practice followed in work with which he has been connected will be given.

## COMPOSITION AND CHARACTERISTICS.

**CEMENT.**—Concrete, as generally used, is made of cement, sand or gravel and broken stone in varying proportions, mixed in various ways. It may be divided into two general classes—that in which natural cement is used and that in which Portland cement is used. The quality of the finished product depends, first, on the quality of the materials used and then on the thoroughness of the mixing. In the choice of cements great care should be exercised. In the writer's opinion, cements of known reliable qualities should be chosen, and then each shipment tested to discover any change in qualities due to change in manufacture. By the use

of certain brands, an intimate acquaintance with the qualities of these brands is obtained.

As a general principle, the writer believes that a natural cement specification should require that the neat tensile strength shall equal 80 lbs. per square inch at the age of 7 days, and 150 lbs. per square inch at the age of 28 days, that it shall be sound and shall be ground to a certain degree of fineness, and that each test shall conform closely with the average determined by previous tests.

The Portland cements should reach a certain neat tensile strength at the ages of 7 and 28 days; this requirement should be moderate in the writer's opinion, being say not over 400 to 450 lbs. per square inch for the 28-day test, and say not over 300 lbs. per square inch for 7 days. The cement should be sound, as determined by the pat test, and it should be finely ground. For ordinary concrete work it should not take its initial and final sets before  $1\frac{1}{2}$  and 4 hours, respectively. And last, but not least in importance, the tests of each shipment of each brand should agree closely with the average results of previous tests of the same brand, and non-conformity should be ground for rejection, notwithstanding the fact that the cement may have passed all other tests satisfactorily.

Some of the reasons why it is a good plan to stick to brands of known good qualities are that: It is difficult, if not impossible, to determine the qualities of a cement by the ordinary short-time tests which may be made by the railroad engineer. Seven-day tests are affected so materially by temperature, the amount of water used in mixing, etc., that they are more or less unreliable. In the course of the work it is frequently necessary to use the cement even before the ordinary short-time tests are made, and if known brands are used little risk is run. The rejection of a shipment of cement is almost invariably followed by loss to the user, due to delays in replacing it and consequent delay to the work. Another advantage in adhering to certain brands is that from long continued use an intimate acquaintance with their action under varying conditions is gained.

**SAND AND GRAVEL.**—The choice of the sand or gravel to be used is fixed largely by the material to be found on the line of the railroad. Certain qualities are generally considered requisite for that used in the manufacture of a first-class concrete. The sand should be coarse and sharp with grains of varying sizes and a small proportion of voids. The use of gravel in place of sand has proved very successful in the experience of the writer. In its use the percentage of sand in it is determined, and the amount of gravel and stone in proportion to the cement is fixed accordingly. The sand and gravel should be fairly clean. Specifications generally call for them to be free from all dirt or other foreign material; authorities differ, however, as to this requirement.

Compressive tests of concrete cubes show that gravel, when used to replace sand as stated above, gives as great strength as the sand mixture. A small amount of dirt in the sand is probably not seriously objectionable if the sand or gravel is suitable in other ways. During the past season, a pit containing a very desirable gravel, except for this one particular, was located in the vicinity of a bridge at which we were building eight concrete piers. The dirt in the gravel had the appearance of containing a large amount of iron and was in considerable quantity, amounting probably to 10 per cent of the volume; unfortunately this was not ascertained exactly. A good gravel could not be obtained on the line without a haul of nearly 200 miles, and it was therefore very desirable to use this, at least in the footings, if it could be done in safety. In order to determine this, tensile tests were made of mortar composed of the sand sifted from this gravel mixed with Portland cement; also compressive tests of concrete cubes using this gravel were made. These tests were compared

with tensile and compressive tests of briquettes and cubes made at the same time, with the same Portland cement mixed with a clean, first-class sand and gravel. The tests seem to show a peculiar state of affairs, and an abstract of the results is given below. The dirty gravel is described as Jackson Pit gravel No. 1 and No. 2; No. 2 having more dirt than No. 1. In the tensile tests the clean sand is described as Hammond Pit, and in the cube tests as Wabasha Pit sand.

COMPARATIVE TESTS OF THE TENSILE STRENGTH OF CLEAN AND DIRTY SAND.

Name of Sand.	Proportions.	Tensile Strength. Lbs. per Square Inch.				Remarks.
		1 day.	7 days.	28 days.	3 mos.	
Hammond Pit.....	1 part Portland Cement to 1 part sand.	95	490	511	457	Hammond Pit sand is a first-class clean, coarse sand
Jackson Pit, No. 1.....		86	464	607	627	
Jackson Pit, No. 2.....		170	501	573	515	
Hammond Pit.....	1 part Portland Cement to 2 parts sand.	79	329	393	492	Jackson Pit sands are both fair sands, except very dirty. The No. 2 is dirtier than the No. 1.
Jackson Pit, No. 1.....		62	377	448	541	
Jackson Pit, No. 2.....		84	402	525	514	
Hammond Pit.....	1 part Portland Cement to 3 parts sand.	59	179	274	349	
Jackson Pit, No. 1.....		39	256	339	430	
Jackson Pit, No. 2.....		69	348	396	396	

It will be seen in the case of the tensile tests that the two samples of dirty sand gave a higher tensile strength for all proportions, at all ages, than the clean sand, except at one day and seven days. In the compressive tests of the concrete cubes it will be seen that in the case of the proportions of 1 part of cement to 2 parts of gravel to 5 parts of broken stone, the clean gravel gave a strength of 158,000 lbs., while the average strength of the two samples of dirty gravel was about 144,500 lbs., only a little less than the clean; while in the case of the proportions of 1 part cement to 2½ parts of gravel to 5 parts of broken stone, the clean gravel gave a strength of 120,600 lbs. and the dirty 133,700 lbs., or about the same difference in the favor of the dirty gravel that there was in the other in-

COMPARATIVE TESTS OF THE COMPRESSIVE STRENGTH OF 12-INCH CONCRETE CUBES  
MADE OF CLEAN AND DIRTY GRAVEL. BROKEN AT THE AGE OF 28 DAYS.

Name of Gravel.	Proportions.			Compressive Strength. lbs.	Remarks.
	Portland Cement.	Gravel.	Crushed Stone.		
Wabasha Pit.....	1 part	2 parts	5 parts	158,040	Wabasha Pit gravel is a good, clean gravel. The Jackson Pit gravels are the same class as the sands in above table.
Jackson Pit, No. 1.....				142,230	
Jackson Pit, No. 2.....				146,780	
Wabasha Pit.....	1 part	2½ parts	5 parts	120,610	
Jackson Pit, No. 1.....				133,680	

stance in favor of the clean. The results of these tests were such that we used the dirty gravel in mixing the concrete for the footings.

A series of tests is now under way in which mortar made of various proportions of cement and sand is being tested in tension and compression. The sand is first taken clean, and then proportions of loam from 2 per cent. to 20 per cent. are added. These tests will cover several years. In any case, the question whether sand or gravel shall be used, and also, within certain limits, what qualities shall be required, is dependent largely on what may be found within a reasonable haul on the line of the railroad making the improvement.

**CRUSHED STONE.**—The crushed stone question is also settled largely in the same way, within certain limits as to quality. To get the best results, crushed stone should consist of fragments not exceeding 2 inches or  $2\frac{1}{2}$  inches in greatest dimension, and the individual pieces should vary in size from grains the size of coarse sand to the maximum. They should be hard, angular and sharp, of such a nature that the sides are not "glassy," and should be free from dirt. Where the stone is hard it may be taken as it comes from the crusher without screening. Pebbles or round stones may be used in place of crushed stone if desired, but with a loss of strength, which may be due to the fact that with the round pebbles there is a greater percentage of voids, or because the adhesion of the mortar to the smooth sides of the rounded pebbles is less than to the rougher sides of the broken stone. Whether the round stone should be used in preference to the broken stone, where either may be obtained, is largely to be determined by cost and strength desired. Where Portland cement

EFFECT OF VARYING PROPORTIONS OF GRAVEL AND CRUSHED STONE.  
NATURAL CEMENT CONCRETE.

No. of Cubes Broken.	Proportions.			Average Com- pressive Strength in Lbs. at 28 Days.	Remarks.
	Cement.	Gravel.	Crushed Stone.		
2	1 Milwaukee	1	..	62,650	
2	1 ..	1	1	77,450	
2	1 ..	1	2	71,650	
2	1 ..	1	3	78,040	
2	1 ..	2	..	85,925	
2	1 ..	2	2	42,850	
2	1 ..	2	3	41,400	
2	1 ..	2	3½	35,690	Failed gradually by splitting and flaking in line of strain.
2	1 ..	2	4	33,880	
2	1 ..	2	5	29,575	
2	1 ..	3	..	31,150	
2	1 ..	3	3	29,000	
2	1 ..	3	4	29,450	
2	1 ..	3	5	15,825	
2	1 ..	3	6	16,050	Disintegrated.
2	1 Louisville	2	2	34,600	
2	1 ..	2	3	37,850	
2	1 ..	2	4	35,300	
2	1 ..	2	5	25,375	
2	1 ..	2½	3	29,400	
2	1 ..	2½	4	30,490	Failed gradually by flaking in line of strain.
2	1 ..	2½	5	24,750	
2	1 ..	3	3	25,625	
2	1 ..	3	4	23,300	
2	1 ..	3	5	15,800	

is used, it is, as a rule, far the most expensive ingredient per unit of volume, in the manufacture of the concrete, and in order to get the same strength with the rounded stones as may be obtained with the angular broken stone, it will be necessary to increase the amount of cement, probably more than enough to make up the difference in the cost of the stone. In the vicinity of Chicago a very good quality of this rounded stone may be obtained, under the name of washed gravel, composed of the pebbles and small stones left after washing the sand from gravel found near that city. It consists of pebbles ranging in size from that of a hazel nut to 2 inches in diameter.

Tests to determine the comparative value of a hard crushed limestone, a soft crushed limestone, and this washed gravel when used in the manufacture of concrete, were made with the results shown in the table.

The gravel used in the above tests was composed of about two-thirds coarse, sharp sand and one-third pebbles from the size of sand to  $1\frac{1}{2}$  inches in diameter. It will be seen from the tests that the hard limestone concrete gave an average strength of about 183,000 lbs., the softer limestone an average strength of about 168,500 lbs., and the washed gravel an average strength of about 151,000 lbs., for the proportions of 1 part of Portland cement to 3 parts of gravel to  $4\frac{1}{2}$  parts of stone. The test of the softer stone alone, compared with the same mixed with the washed gravel in equal proportions, strengthened the belief in the superiority of the soft limestone over the round pebbles of which the washed gravel is composed. It is not always possible to have the best crushed stone or other material within a reasonable haul of the point of use, and it then becomes necessary to make the best use possible of the material in hand.

**STRENGTH AND COST.**—The strength and cost of concrete are dependent, within certain limits, on the proportion of the ingredients. As before said, the cement is usually much the most expensive of the ingredients per cubic foot. In general terms, that arrangement of proportions which gives the desired strength of concrete with the use of the least amount of cement is the most economical for the work under consideration. In the case of natural cement concretes made of cement sold in the markets of the Middle West, the price of which is only from four to five times the cost of broken stone per unit of volume, the strength developed within the short period of time during which it may usually be permitted to set before loading is comparatively low. The proportions of materials are therefore usually fixed for the greatest strength obtainable, and without regard to the amount of cement required. A preliminary series of tests to determine, if possible, the proper proportions to be used in mixing concrete with the materials we had was made in 1898. The tests were on 12-inch cubes at the age of 28 days, this age having been used largely in the concrete tests of the writer, because it is frequently necessary to load structures built of concrete at that age. The materials other than the cement used in making the concrete for the cubes were the same gravel described previously, composed of about two-thirds sand and one-third pebbles and a hard crusher-run limestone. The proportions used in the Portland cement concrete tests varied from 1 part of cement, 1 part of gravel, 1 part of broken stone, to 1 part of cement, 4 parts of gravel, 4 parts of broken stone. Two brands of cement were used in this test and the tests of the two brands were made under different conditions, so that their results may not be compared. The proportions used in the natural cement concrete tests varied from 1 part of cement, 1 part of gravel, to 1 part of cement, 3 parts of gravel, 6 parts of broken stone. Two brands of cement were used in this test also, and as the tests were made under different conditions, the results of the two brands may not be compared. The results are given in the tables.

**COMPARATIVE TESTS OF COMPRESSIVE STRENGTH OF 12-INCH CONCRETE CUBES MADE WITH DIFFERENT CRUSHED STONE.**

No. of Cubes Broken.	Proportions.		Stone.	Average Compressive Strength at 28 Days. Lbs.
	Portland Cement.	Gravel.		
3	1 part.	3 parts.	4½ parts hard crusher-run limestone .....	183,180
2	1 part.	3 parts.	4½ parts soft screened limestone .....	168,580
3	1 part.	3 parts.	4½ parts washed gravel .....	150,890
3	1 part.	4 parts.	7 parts soft screened limestone .....	103,000
3	1 part.	4 parts.	3½ parts soft screened limestone .....	92,430
			3½ parts washed gravel .....	

The results seemed to indicate, in the case of the natural cements, that, given a certain proportion of cement and gravel, the addition of the crushed stone to this mixture would not affect the strength materially until a certain amount had been added, which coincided closely with the point where the voids in the stone exceeded the volume of the mortar,

**EFFECT OF VARYING PROPORTIONS OF GRAVEL AND CRUSHED STONE. PORTLAND CEMENT CONCRETE.**

No. of Cubes Broken.	Proportions.			Average Compressive Strength in Lbs. at 28 Days.	Remarks.
	Cement.	Gravel.	Crushed Stone.		
2	1 Alpha	1	1	178,600	Failed gradually by splitting and cracking in line of strain.
2	1 "	1	2	200,000	Failed gradually by splitting and cracking in line of strain.
2	1 "	2	2	194,675	Failed one cube unbroken at 200,000 lbs.
2	1 "	2	3	200,000	" gradually by splitting in line of strain.
2	1 "	2	4	200,000	" " " " " "
2	1 "	2	5	175,800	" " " " " "
2	1 "	3	3	180,325	" " " " " "
2	1 "	3	4	197,175	" " " " " "
2	1 "	3	5	185,000	" " " " " "
2	1 "	4	4	141,500	" " " " " "
2	1 Atlas	2½	3	185,000	Unbroken at 185,000 lbs.
1	1 "	2½	4	178,100	Failed gradually by flaking and cracking in line of strain.
2	1 "	2½	5	151,750	Failed gradually by flaking and cracking in line of strain.
2	1 "	3	3	181,450	Failed gradually one cube unbroken at 185,000 lbs.
2	1 "	3	4	159,925	Failed gradually by flaking and cracking in line of strain.
2	1 "	3	5	170,700	Failed gradually by flaking and cracking in line of strain.
2	1 "	3	6	119,850	Failed gradually by flaking and cracking in line of strain.
2	1 "	3½	4	185,000	Failed gradually one cube unbroken at 185,000 lbs.
3	1 "	3½	5	178,700	" " " " " "
2	1 "	3½	6	185,000	Unbroken at 185,000 lbs.

after which the strength decreased materially on the addition of more stone. The strength was not affected materially; it was not decreased, but if anything was increased, by the addition of stone up to the point mentioned. Also, the tests indicated that the strength of natural cement concrete was dependent, primarily, on the proportion of cement to sand, decreasing with each added part of sand.

The tests of Portland cement concrete cubes gave the same results with regard to the amount of stone used with a given sand and cement mixture, but gave a different result with regard to the strength of varying sand and cement proportions. The results of strength obtained showed little if any change in the compressive strength of the different mixtures until after so much gravel had been added that the voids in it were in excess of the amount of cement used, when the strength decreased rapidly, seeming to indicate that there was little advantage, as far as strength was concerned, in using a mixture in which the cement was much in excess of the voids in the sand or gravel, or the sand and cement mortar in excess of the voids in the stone.

The proportions used by the writer, in work under his directions, are as follows:

For all natural cement concrete, 1 part of natural cement to  $1\frac{1}{2}$  parts of sand to not exceeding 4 parts of broken stone.

For Portland cement concrete, where a rich mixture is desired, 1 part of Portland cement to 2 parts of sand to not exceeding 5 parts of broken stone; and where a rich mixture is not necessary, 1 part of Portland cement to 3 parts of sand to not exceeding  $7\frac{1}{2}$  parts of broken stone.

In the writer's practice gravel is substituted for sand wherever it can be obtained conveniently, and the proportions used are then about 1 part of natural cement to 2 parts gravel to  $3\frac{1}{2}$  parts of broken stone; and 1 part Portland cement to 3 parts of gravel to  $4\frac{1}{2}$  parts broken stone; and 1 part Portland cement to 4 parts gravel to 7 parts broken stone. Where gravel is used he finds that frequently a little more broken stone can be added. With these proportions the cement required per cubic yard of concrete, as shown by averages taken from a large volume of work, is about as follows:

For natural cement concrete (1:1 $\frac{1}{2}$ :4).....	1.5 barrels.
" Portland " " (1:2:5) .....	1.2 "
" " " (1:3:7 $\frac{1}{2}$ ).....	0.9 "

With the gravel described, about 0.8 cubic yards of broken stone and 0.5 cubic yards of gravel are required per cubic yard of concrete of any of the proportions given.

### MANUFACTURE.

MIXING.—Concrete is mixed both by hand and by mixing machines especially designed for the purpose. In hand mixing the method favored by the writer is to spread the sand or gravel in a thin layer on the floor of a water-tight box and then the cement evenly over the top of it. The two are then thoroughly mixed dry, after which all the water required is added and the mass again mixed. During this time another set of men have spread the stone evenly over a second water-tight platform alongside of and 4 inches to 6 inches lower than the mortar box. If the stone is a soft or porous one, or if the weather is warm and dry, it is wetted and then the mortar is distributed over it by means of shovels, scoops or hoes. The mass is then turned until each particle of stone is surrounded by a coating of mortar, generally about three turnings being sufficient. It is then ready to be wheeled to place.

There are two general classes of mixing machines used in the making of concrete—the screw mixers and the revolving box mixers. The principle of the screw mixer is a horizontal shaft with either a continuous blade or set of paddles fastened spirally to it, working in a trough slightly larger than itself. At one end is generally a chute through which the materials are dumped on the continuously moving screw by which the material is conveyed from the end where it is charged to a chute at the other end where it is discharged and wheeled to the work. In traveling this distance the action of the screw rolls it over and over and mixes it. There is no way to control the amount of mixing with this class of machine. Sometimes the materials are dumped at the same time, or the sand and cement are dumped together, the stone farther along and the water added still farther along the screw. Occasionally, the materials are shoveled directly from platforms to the screw, the men timing their work so that the right proportions are maintained. The quality of the mixture depends largely on the way in which the materials are delivered to the screw. If they are delivered properly a good concrete will result, but if not, then a concrete rich in one ingredient at one time will be followed by a mixture poor in the same ingredient.

Of the revolving box mixers, there are a number of different kinds. One of the most common is a cubical steel box with a door in one side or one corner through which it is charged and discharged, revolving on a hollow horizontal shaft. The cement, sand and stone are dumped into the mixer through the door by means of a chute, and, after a few turns to dry mix the materials, the necessary water is added through the hollow shaft; then after a certain number of turns more the box is stopped and the mixed product emptied and wheeled away. The amount of mixing is entirely under the control of the operator, but it is necessary to stop and start the mixer for each separate charge. With this form of machine there is the disadvantage that the operator cannot see the process of mixing. A modification is one in which the box is not in the form of a cube but is many-sided.

Another form of mixer is in the shape of a hollow cylinder, on the inside of which are two movable blades or deflectors, about 4 inches to 6 inches wide, placed parallel to the axis of the cylinder and diametrically opposite each other. Between these two movable blades are four fixed blades arranged to deflect the material from side to side during the process of turning. In each end of the cylinder is a circular opening. Through one of these the concrete materials are dumped into the mixer by means of specially shaped wheelbarrows, and into the other an inclined tray or trough extends through to the opposite end of the cylinder. This tray is hinged in its middle parallel to the axis of the cylinder, so that it may be closed on itself during the process of mixing. The cylinder is placed with its axis horizontal on four anti-friction rollers bearing on a projecting rim on the ends and a little larger than the circular openings mentioned. It is turned by power applied to the rim of the cylinder. The process of mixing is as follows: The required amount of water is discharged into the continuously revolving cylinder through a pipe extending into it through the circular opening at the discharge end. The materials properly measured are then charged into it in the order of, first cement, then sand, and last broken stone. The blades or deflectors on the inside of the mixer deflect the materials from side to side and thoroughly mix them together. During the process of mixing the movable blades are placed in such a position that the mass is carried over the chute or tray. When mixed sufficiently they are changed so that the concrete is raised up and discharged on to the inclined chute, down which it slides into the wheelbarrows placed beneath the end. The movable blades are under the control of the machine tender, who stands at the discharge end of the mixer.

With this machine the operation is under the observation and control of the operator at all times, and mixing may be carried on as long as he desires. The writer is more familiar with it than any of the others described, having two of them on work under his direction, one of a nominal capacity of 75 cubic yards and the other of 50 cubic yards in 10 hours. This capacity may be doubled, however, by either of the machines. In the writer's opinion it is impossible to mix concrete any better than it is mixed by this machine, and that it cannot be equaled by hand when a soft or porous stone is used. A very convenient form of this mixer for railroad and other work, where the jobs are not large and are scattered, is that in which the mixer and a gasoline engine to run it are mounted on wheels on the same frame. Where frequent moving is the rule this is of great advantage, saving both time and money in moving and setting up.

The question is often asked as to whether hand mixed or machine mixed concrete is the better. As to quality, the writer believes that with either the cubical or box mixer and the cylindrical mixer just described it can be mixed better than by hand, and the chances are that it will be, and that with the screw form of mixer the quality of the finished product depends very much on the care, and the chances are that it will be no better than that mixed by hand. Where the amount of concrete to be built at one locality is reasonably large, there is little question but that machine-mixed concrete is the cheaper.

**WATER.**—The amount of water to be used in mixing is a question on which there has been much discussion, and practice in this respect varies widely. A few years ago it was the almost universal rule that concrete was mixed just wet enough so that repeated ramming was required to bring moisture to the surface. This practice has been gradually changing until at the present time many engineers prefer a moderately wet concrete or even one which quakes under slight tamping. There are many advantages in favor of the wetter mixtures and the writer believes that in general better results are obtained by their use. Comparative tests of the strength of wet and dry mixtures point to the fact that at short times the strength developed in laboratory tests is somewhat greater in the case of the dry mixture than in the case of the wet, but that the latter eventually becomes as strong as the former.

The practical advantages in favor of the wetter mixture are that it is very much easier to mix the ingredients well together when plenty of water is used; that the cement sets slower, allowing the concrete to stand longer without damage; that there is a better union between succeeding courses and that less tamping is required to get a compact mass, and for work above ground the surplus water provides for the absorption of water by the wooden forms and the evaporation due to the atmosphere. The writer is in favor of a quaking concrete for work above the ground, especially during the summer months. The amount of water used should be decreased during cool or freezing weather.

**COURSES.**—Concrete should be deposited in layers not exceeding 6 inches in thickness and compacted as much as possible by tamping. If a much thicker layer is used the effect of the tamping will be expended on the top and will not reach through to the bottom. As far as possible each layer should be deposited before the one previously placed has set. In ordinary work it is impossible to carry on work continuously, that is, night and day, but where the work is of sufficient magnitude it is of advantage to do so; whenever a layer of concrete is placed on one which has already set, a horizontal crack may form. To prevent this as far as possible, the top should be cleaned, wet and covered with a thin grout.

It is frequently advisable also to use some device to lock courses together, as for instance the footing and neat work. After the footing

is completed it is usually necessary to allow it to stand for some time while the form or mold for the neat work is being built, and its top becomes more or less dirty, and some of the dirt is apt to remain in little depressions, preventing a perfect union with the neat work. The footing is also frequently of natural cement concrete and the neat work of Portland cement concrete, and the union between these two may not be as strong as it would be if both were of the same class of concrete. In cases like this the writer finds it desirable to use a device similar to one of the following: A groove is formed in the top of the last layer by placing in it, with the top even with top surface of the layer, one or more lines of plank or other timber slightly beveled to facilitate easy removal when desired and leaving them there until ready to start concreting again, when they are taken out. This will form a trough or groove into which the next layer will enter, locking the two together. Where pieces of good stone of moderate size may be readily obtained, a number of them may be placed in the last layer, not too close together, with about half of each stone projecting above the top of the layer. When the next course is built, these stones serve the same purpose as the groove formed by the plank in locking the layers together. Instead of the stones iron dowels may be used to good advantage. In any case there should be no stoppage within less than 18 inches of the top of the wall.

**FACING.**—The question as to whether the exposed surface of concrete subject to the action of water or the weather should be protected by a facing of mortar is one on which there is a diversity of opinion. There is some question as to its necessity as a protection, and in the case of natural cement concrete some uncertainty as to whether it will not eventually separate if it is made of Portland cement mortar. In putting on the facing, when it is used, much depends on the method followed. It may be laid down as a general rule that it should be built up at the same time as the concrete backing and both tamped well together. A convenient tool used by the writer for several years for this purpose consisted of a piece of steel  $\frac{3}{4}$  inch thick, 6 inches wide and from 4 feet to 6 feet long, on one side of which is riveted two  $1\frac{1}{2}$  inch  $\times$   $1\frac{1}{2}$  inch angles, 6 inches long, at right angles to its length and 6 inches to 12 inches from the ends; on the other side are riveted two handles. In place of angles being riveted on one face the ends may be bent over  $1\frac{1}{2}$  inches. This tool is placed with the angle side next to the form or mold, and the  $1\frac{1}{2}$  inch space between it and the mold is filled with mortar and the concrete is deposited back of it, after which it is pulled out and both the concrete and facing tamped. This forces the stones of the concrete into the mortar, and they become one mass, giving a  $1\frac{1}{2}$  inch mortar face, the thickness of facing recommended, where one is desired. For ordinary bridge abutments, low piers or culverts built of Portland cement concrete, a good, smooth wearing surface may be made by working a spade up and down several times along the side of the form. A very good bearing surface on top may also be made by using a fairly wet concrete and smoothing it carefully.

Where facing is used, a mortar of 1 part Portland cement to 3 parts of sand is used, as a rule. Too rich a facing causes a tendency to form hair cracks in the surface. The added cost of facing concrete is considerable, both in material and labor, and the extra amount of cement is quite an item, especially in the case of a narrow wall or of a pier. In the case of the Portland cement concrete abutments built in connection with the elevation of the Chicago, Milwaukee & St. Paul tracks in Chicago, the cement used in putting a  $1\frac{1}{2}$  inch facing of 1 cement to 2 sand mortar on fairly heavy abutments amounted to about 9 per cent of the cement used in the entire neat work. Also, in the case of a narrow wall, the

speed of the work is frequently impeded by the inability to carry up the facing fast enough, and in any case two or more extra men are needed to mix and carry mortar and to attend to placing the facing inside of the form. For these reasons it is advisable to omit the facing where possible. In the case of Portland cement concrete, it is a question as to how much it adds to the weather-resisting qualities. A convenient tamping iron is made with a cast-iron base 6 inches or 7 inches square, weighing about 30 pounds, with a  $1\frac{1}{4}$  inch gas pipe screwed into it for a handle.

### EXPANSION AND CONTRACTION.

Concrete expands and contracts with variations of temperature at about the same rate as iron, and allowance should be made for this in building long walls. In ordinary abutments or culverts where the wall is not over 60 feet long, the writer has not been in the habit of making any allowance, but for greater lengths he is in favor of dividing the wall into about 40-foot sections. The method followed is to build a bulkhead at the ends of the proposed sections, these bulkheads being removed as soon as the concrete has sufficiently set in a section, and the next section is built against the vertical face of that previously built. There will undoubtedly be a bond between the adjacent sections, but a joint will be formed which will be weaker than the rest of the wall, and when contraction takes place a vertical crack will open up at that point. In building the bulkhead a plank is placed vertically on the side against which the concrete is deposited to form a vertical groove, which groove is filled when the next section is built, thus locking adjoining sections in the same vertical plane. By this arrangement the locations of vertical temperature cracks are fixed by the engineer, in the most suitable places, and instead of unsightly crooked cracks we get straight vertical joints. Walls are also frequently divided into short sections, so that each section may be completed continuously, or with a minimum number of stoppages, and therefore with fewer chances of horizontal cracks appearing. Very small cracks, which it would be difficult to find in stone masonry, show up very plainly in concrete, and it is probable that as many cracks are formed in stone masonry as are formed in similar classes of concrete.

### METAL TIES AND STRENGTHENERS.

Concrete adheres very closely to iron or steel, and their use to strengthen or to tie different parts of a concrete wall together is a common practice. Old rails, old Howe truss rods, I-beams, bolts, and old chains are used in this connection. In the case of the main pier of a drawbridge built in Chicago during the early part of last year, old Howe truss rods were embedded in the concrete in such a way that they would hold together different parts of the pier which might have a tendency to separate, and vertical and horizontal rails, as well, were placed in it to add to the strength. Rails are built into footings frequently where the ground is a little soft to add stiffness.

In the case of culverts resting on a soft soil and over which a high fill is made there is a tendency to crowd out the ends of the culvert in the direction of the length; that is, to stretch the culvert. This is shown in the case of iron pipe culverts, which are frequently unjointed by the same force. In order to prevent this elongation in one case, there was built in each of the footings of a culvert in a high fill a line of wornout chain, and in another case two lines of light narrow-gauge rails were used, through the bolt holes of which drift bolts were placed to add to

the resistance of the rail to pulling through the concrete. It is said that concrete is a preventive of rust, and this seems to be borne out by fact, inasmuch as it is reported that pieces of iron found in mortar placed long ago are still free from corrosion.

### FORMS.

The construction of the form or mold for the ordinary low abutment or culvert wall is a comparatively simple matter. The practice followed by the writer is to use 4 inch x 6 inch or 6 inch x 6 inch uprights, with 2 inch plank surfaced on one side and two edges lightly nailed against the posts to form the faces of the wall. A uniform width of plank has been selected to facilitate its use, and a 10-inch width has been settled on as a convenient size. The front and back faces of the form are held at the proper relative distance of each other by means of rods through opposite posts. The front is usually held in line by bracing to stakes driven in the ground, or to the piles, if built through a pile bridge. For the ordinary culvert or low abutment a rod at the bottom and top of each opposite set of posts, of the dimensions stated, has been found to be sufficient. The bottom rod is located usually below the surface of the ground and is left in the concrete, and the top rod, where possible, is placed through the posts above the top of the wall and is removed when the form is taken down. When it is not placed above the top of the form, or when more than two rods are used, they are cut off at the face of the concrete and left in the wall. In the case of the smaller culverts, it is frequently possible to brace between the front side of the forms of the two walls and to hold the backs of the forms in place by blocking against the piles or bank, and in this way omitting the rods. The face planks are required to be placed level. Where an especially smooth surface is desired, the planks for the face are surfaced both sides and to a specified

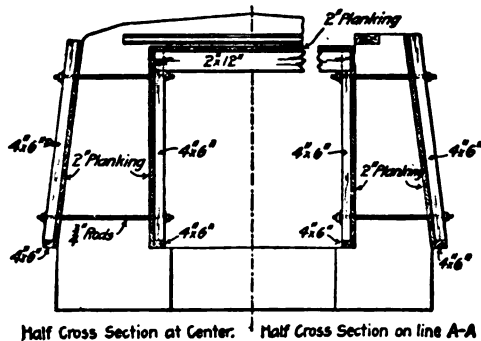


Fig. 1.—Plan of Concrete Forms for Rail Top Culverts.

thickness. Fig. 1 shows the standard plan of concrete form used by the Chicago, Milwaukee & St. Paul in building rail-top culverts.

The posts are spaced either 5 feet 4 inches or 4 feet centers where 16-foot planks are used. For high piers or abutments a heavier post is used, say 6 inches x 8 inches, or 8 inches x 8 inches, or two 3-inch planks bolted together, with 1-inch blocks between them. These are placed so that the planks are nailed against the edges and the rods passed through

the space between the plank, with the nut and washer against the outer edge. In the case of arches the lagging is beveled to give a fairly tight upper surface.

For round pier noses or turntable pits, planks of a suitable width to form the rounded part are placed vertical. Sharp edges, on account of the liability to chip off, are objectionable, and a  $\frac{1}{4}$ -round cove is tacked in each square turn of the forms, giving a rounded corner in the finished wall. Various sizes of cove are manufactured, thus permitting the selection of a size suitable to each special place. The tops of wings of culverts and abutments are built on a slope to correspond to the slope of the embankment. In making the forms for the wings the ends of the plank are not sawed off to conform to the slope, but a strip of cove of a suitable size is nailed on each face of the form, with its top on a line with the proposed top of wing; the concrete is deposited roughly to the proper height and then struck off with a straight edge, resting on the strips mentioned. The same method is used to advantage in finishing the top of abutments and piers.

For small piers of the same size, the forms may be made in sections which may be taken down from one pier and set up for use at another, but for other railroad structures the sizes and shapes are so diverse, that as yet we have been unable to devise a satisfactory kind of removable form. The lumber used in building the forms may be used over and over if care is taken in handling. The cost of material and labor in building forms for the ordinary culvert or abutment will be between 35 cents and 85 cents per cubic yard of masonry, depending on the simplicity of shape and the size of the wall. The construction of the form is susceptible of considerable improvement.

In the writer's practice it is the custom usually to finish the form for any particular part before starting the concrete in it. Others carry up the sides of the form as the concrete is deposited, but this necessitates more or less sawing and fitting, and chips and sawdust are apt to be scattered on the top of the layer last deposited, making a more or less defective joint, and also necessitates more or less unnecessary tramping on a possibly partly set concrete. It also requires two different sets of workmen to be employed inside of a narrow space, and they unavoidably interfere with each other.

### HANDLING CONCRETE.

In placing large masses of concrete, machinery other than the mixing machine may be used to advantage in reducing the cost and facilitating the work. In the construction of the abutment and main pier of a 175-foot counterbalance girder swing bridge, built in Chicago during 1899, the following arrangement was used: The abutment and pier mentioned were part of the circumference of a circle 67 feet in diameter, each part extending over about 90 degrees and being diametrically opposite each other. A concrete mixer was placed about 50 feet from the center of the circle, and from the discharge side towards the center a push-car track was built, a derrick being placed as near the latter point as possible. As the concrete was mixed, it was discharged into  $\frac{1}{2}$ -yard steel dirt buckets, placed on a push car on the track mentioned, then run within reach of the derrick, when it was picked up, swung around, lowered into place and dumped just where required. This arrangement resulted in increased rate of progress and saving in cost.

In the construction of high piers and abutments where the mixing platform cannot be built near the level of the top of the structure, it is our aim to use some power, other than man, to raise the concrete to the

top of the wall and have the wheeling on level runways. One method adopted has been to build a frame with a platform slightly above the top of the wall with two uprights extending about 7 feet above the top of the platform. Between the tops of these uprights a cross-piece with a sheave over an opening in the platform is placed. The wheelbarrow loaded with concrete is raised through this opening in the platform by means of a rope passing up and over the sheave mentioned. The barrow is guided by means of a vertical groove, in which the wheel travels, and a vertical plank is so placed that it guides the handles. For low lifts, where the amount of concrete is not too great, a horse is used for power. For high lifts and where a large amount is mixed per day a 4-horse-power gasoline engine has been rigged up with a spool of a size to give the desired speed of hoisting. The engine runs continuously, and when a load is to be lifted a couple of turns of the hoisting rope are taken around the spool; when the barrow is landed the rope is thrown off from the spool and lowered, ready for another load.

The empty barrows are lowered by means of a rope passing over a sheave, to one end of which they are fastened and to the other end of which is a counterweight. Another scheme used has been to suspend two platforms, each large enough to take a barrow in a frame in such a way that when one is raised the other is lowered. A team is used to operate this, raising the loaded barrows up to the proper level and lowering the empty barrows to be filled.

#### THE AGE AT WHICH CONCRETE MAY BE LOADED.

The effect of temperature on the rate of the initial hardening of concrete is marked. During hot summer weather it sets very much faster than in cooler weather; this is reflected in the tests of strength of cement, certain brands showing considerably higher results in short-time tests in summer than in winter, unless an even degree of heat is maintained in the test room. In consequence of this fact, the load to be carried by the concrete structure may be applied sooner in midsummer than in the spring or fall. It is difficult to answer this query with regard to any certain piece of concrete work, as the time required varies both with the class of structure and the class of concrete. In the writer's experience, it has been necessary to erect steel girder spans on Portland cement concrete abutments two weeks after their completion in warm summer weather, and this was done without injury. Then, again, it became necessary, early in March, to erect girder spans on Portland cement concrete work finished early the previous December. In drilling for the anchor bolts the foreman reported that the concrete was "not very solid inside." It might not have been as hard as it would have been after two weeks in midsummer.

The question as to whether the loading is quiet and gradually increasing, like that sustained by a culvert or retaining wall during the process of filling, or whether it is all applied at once and is subject to impact, as in the case of a bridge abutment or pier, has a good deal to do with the decision as to when it is advisable to put the structure into service. As a general rule, bridge abutments and piers of Portland cement concrete should be allowed to set at least a month before using if built during ordinary warm weather; if built, however, during cold weather, they should not be used until warm weather if their use can be deferred. Natural cement concrete structures are rarely subject to impact, and the load is generally gradually increased. On account of the slower setting qualities, however, it is well to allow two months for setting, if possible, during warm weather.

This leads to the question of the strength of concrete of the ordinary proportions. The crushing strength of 12-inch cubes of Milwaukee and Louisville cement concrete of 1 part cement to  $1\frac{1}{2}$  parts sand to 4 parts broken stone at the age of 28 days ran about 35,000 pounds in tests by the writer. The crushing strength of 12-inch cubes of Portland cement concrete at the age of 28 days of 1 part cement to 2 parts sand to 5 parts broken stone ran about 175,000 to 200,000 pounds.

### CONCRETE BUILT IN COLD WEATHER.

The question whether concrete work should be carried on in freezing weather has been discussed frequently, and with varied decisions. It seems to be widely accepted of late, however, that that made with Portland cement may be safely mixed and placed during freezing weather, if proper precautions are taken, the only defect appearing being a possible flaking of the surface. The writer has known of many footings of Portland cement concrete put in during extremely cold weather which, so far as any appearance, as shown by the masonry resting on them, are in good condition. He has also had occasion to build Portland cement concrete above the ground during freezing weather, and which came out apparently uninjured.

The effect of freezing on freshly mixed natural cement concrete is more uncertain. That it can be built during freezing weather without apparent injury, except a slight flaking on the face, he knows from experience. That concrete built with the same proportions of materials and of the same cement may be seriously damaged when built during freezing weather he also knows from experience. It is said that alternate freezing and thawing of freshly placed concrete is a much more severe test than when it remains continuously frozen. During the months of February and March, 1899, the writer made a number of tests to indicate the effect of severe cold on the compressive strength of Atlas, Portland and Louisville cement concrete cubes. The cubes were 12 inches on a side. The Atlas cement concrete was of the proportion of 1 part of cement to 3 parts gravel ( $\frac{1}{4}$  sand and  $\frac{1}{4}$  pebbles) to 4 parts hard crusher-run limestone. The Louisville cement concrete was of the proportion of 1 part cement to 2 parts gravel to 4 parts broken stone.

Eight cubes of each kind of concrete were made at the same time by the same person, and they were all left in the molds of 1-inch lumber until broken. Two cubes of each, for purposes of comparison, were left in a warm office all of the time until broken at the age of 28 days; two of each were placed outdoors in a temperature below zero Fahr. as soon as made, and left outside until broken at the age of 28 days; two of each were placed outside at the same time as the two just mentioned and left outside 28 days, then brought into the warm office and left for 28 days in the warm, when they were broken; two of each were mixed with salt water and placed outside as soon as made, the same as the above, and left out for 28 days, when they were broken. During the first part of the 28 days the temperature was very low, getting as low as 10 degrees to 20 degrees below zero; during the latter part, however, the weather moderated and thawed during the daytime and froze during the night.

In the case of the Atlas cement concrete the compressive strength at 28 days of the two cubes left in the warm office and the two cubes mixed with salt water exceeded the capacity of our testing machine, 185,000 pounds. The two cubes left out in the cold for 28 days and then brought inside for 28 days also developed a strength of over 185,000 pounds. The two cubes placed outside to freeze and broken at the end of 28 days developed a compressive strength of 114,800 pounds. The deductions which

were drawn were, first, that the salt seemed to neutralize, to a great extent, the effect of the freezing, and, second, that, notwithstanding the fact that the concrete was frozen before setting, the process continued, although slower, and that the only apparent effect of the freezing was to retard the setting.

In the case of the Louisville cement concrete at the age of 28 days the two cubes left in the warm room developed a strength of 43,400 pounds; the two left out in the cold for 28 days, 32,300 pounds; the two mixed with salt water and left out in the cold for the same length of time, 35,000 pounds; and the two left out in the cold for 28 days and then brought into a warm office for 28 more days showed a strength of 52,500 pounds. In the case of this cement the use of salt seemed to have little, if any, effect. The cold seemed to have the same effect as in the case of Portland cement; that is, to retard the rate of setting.

These tests were made only on a small number of cubes and cannot be considered as at all conclusive, but they at least served as an indication of the effect of freezing on concrete. In the writer's opinion, it is not advisable to make natural cement concrete during freezing weather if it is to be placed where it will be exposed to the action of the weather, but Portland cement concrete may be made without danger under the same conditions, if care is used. When concrete is made during or just before freezing weather the form should be left on until warm weather.

### USES.

The uses to which concrete may be put in railroad work are many and varied. The writer believes it may be used for almost every purpose for which stone masonry is now used and for some purposes for which stone masonry cannot be used. Those uses to which each of the two classes of concrete are being put will be briefly mentioned.

Natural cement concrete is being widely used for all classes of foundations where the loading is not excessive, the soil fairly firm and where there is little water to contend with. The approved method of putting in footings of this kind in material which will stand, is to dig a trench of the neat size of the footing and fill it full of concrete. It is being used to build low earth retaining walls which are far enough removed from the track to be comparatively free from the vibration due to passing trains.

It is also being used, to a limited extent, to build the walls of smaller sizes of culverts. There is a question as to the advisability of placing it above the surface of the ground, inasmuch as the action of frost on it, even after it has set, is somewhat uncertain, especially in the case of culverts in which there is standing water during the cold winter weather. The difference in cost between it and Portland cement concrete makes it advisable to use it wherever it can be done with safety. For prices of cement current in Chicago there is a difference in cost of about \$1.25 per cubic yard in favor of the natural cement concrete over that of the cheaper Portland cement mixture previously mentioned.

Portland cement concrete has a wider variety of uses. It is used for all kinds of footings where there is much water to contend with or where the loading is heavy. It is used for retaining walls of all kinds, especially high ones or those built so close to the track that they are subject to the vibration and shock of passing trains. It is used in building the walls of all classes of culverts, both rail top and arch. In the case of the first, this concrete is used both in building the walls and surrounding the rails in the cover. It is a very convenient form of masonry for arch construction, especially of the ring, as it does away with the necessity of the cutting of the

stone, and, if properly built, each section of the ring will be practically a monolith and will be stronger than the ordinary brick or stone arch. The nature of the material also permits the use of steel in the form of rods, l-beams, or other shapes in the ring to add strength. In building the arch ring it is well to divide it into sections at right angles to the axis of the arch of such width that each section may be placed during one working day. This may not be of great importance, but will undoubtedly add to the strength. By the use of rods or beams in the ring very flat arches may be constructed. The arch ring should be constructed of the richer mixture of concrete, but in general the footings, bench walls and spandrel backing may be built of the weaker mixture, where the arch is not over 12 to 15 feet span.

Bridge abutments and piers are built of Portland cement concrete. During the past two seasons over 40,000 cubic yards of Portland cement concrete have been placed in culverts, piers and abutments on the railroad on which the writer is employed, and the first serious defect is yet to appear. In the case of piers, it is our custom to place a number of old rails vertically in the concrete, the number being fixed by the size and height of the pier. They add strength and resistance to shear and are especially useful in a stream which has much ice in winter. It is also good practice in the latter case to build the pier with a cutting nose, protected by a bent steel plate, or two plates and an angle, this steel protection piece to be fastened to the concrete by means of bolts, each having a large nut or washer on one end, which is built into the body of the pier. The nose piece is fastened inside of the form, and the concrete is built against it and around the bolts just mentioned.

Another use to which concrete, from its nature is adapted very nicely, is the re-enforcement or strengthening and the protection of old stone masonry, which is being disintegrated by the action of the weather. Most lines which have been built for a number of years have a greater or less amount of stone masonry built of inferior classes of stone, which show, in varying degrees, the effects of the weather, or in the course of the improvement of grades it becomes necessary to add to the height of abutments, increasing the load thereby, beyond that for which they were designed. Concrete may be used to protect the decaying stone in the first place, and, if there is room, to re-enforce the wall in the second case. During the last season both cases were involved in one problem which came up for solution. A pair of abutments about 20 feet high, built in the early years of the company, of a native stone, which would not resist the action of the frost, and set in lime mortar, was in such a condition that it was only a question of a few years before it would be necessary to rebuild it from the surface of the ground, unless it could, in some way, be protected from the action of the weather. To complicate matters, the grade across the bridge was to be raised 3.6 feet. It had at various times previously been raised several feet, so that when the track was finally at the proposed grade it would be about 6 feet higher than it was originally. The changes thus required were raising the main wall and wings of each abutment, and lengthening the latter. The plan finally adopted was to re-enforce the wall in front with concrete, making it heavy enough for the increased height of bank behind it, to lengthen the wings and raise them and the bridge seats and back wall to the proper height. This amounted to building around the old abutment on all sides, except the back, a casing or shell of concrete. In order to make a good bond between the old stone masonry and the concrete all of the rotten pieces of stone were removed from the face, the joints were cleaned out and then the face and joints were washed just before the concrete was placed against it. In addition, a number of holes were drilled into the face and top of the old masonry and key bolts

wedged into them, with the head, on which was a large cast washer, projecting from 8 inches to 15 inches. The concrete was also carried far enough down the back of the wall to prevent water working into the horizontal joint on the top of the wings and the main wall. The writer has no doubt but that this will prove effective.

In another instance, the grade was raised  $7\frac{1}{2}$  feet across a bridge, consisting of three steel girder spans resting on skew cut-stone piers and square wing abutments, also of cut stone. The raise was effected by means of concrete, built in place under the girders after they were raised to grade. The rounded ends of the concrete on the piers were formed by means of steel shells. These steel shells were held in place by rods and were left to give additional strength. A short span was added at each end of the bridge to take the slope and a rectangular concrete pier was built on each abutment of the proper height to bring the masonry up to grade.

Concrete has been largely used as a backing for large piers and as a filling for cylinder piers, with success in both cases. Portland concrete may be used to good advantage in building the circular walls and floors of turntable pits.

Either Portland or natural cement is used to good advantage in constructing the foundations of buildings. During the past season we constructed the foundation and wall, up to the water table, of a large freight house, of Portland cement concrete, with a very pleasing effect to the eye. The floor of this freight house was also built of the same material. As to whether the latter will stand the heavy wear satisfactory, time only can determine, but the chances are that it will prove as good as any other material which could have been used. The writer thinks it might be employed with good results in many cases in the construction of station platforms.

### SUMMARY.

Various advantages in the use of concrete as a form of railroad masonry have been intimated in the foregoing. The writer wishes to summarize them as they have developed in his experience with it and other forms of masonry. One of the greatest in its use on lines where the volume of traffic is large is the fact that it does away with the necessity of using derricks, which are a constant source of interference with, and danger to, trains. With concrete work, the only use of the main track is during the unloading of the necessary material. Concrete may be put in with unskilled labor. The only requisite is a first-class foreman and good engineering supervision. In these times of constant labor agitation, this is of itself an exceedingly important item. This fact also makes easy rapid expansion and contraction of the force to suit the requirements of the work in hand, permitting the crowding of the work during favorable weather and during seasons when large amounts of permanent work are desired.

There is a wider distribution of suitable concrete materials than those required for stone masonry. In general, any stone which is suitable for stone masonry will make crushed stone suitable for concrete, as will also a great deal of stone that is not suitable for stone work. Sand that is suitable for mortar for stone masonry is also suitable for concrete. But gravel is only suitable for concrete when it has been screened.

In general, concrete construction requires less false work to carry the track than other forms of masonry, in that, with proper care, in many cases, the wall of the culvert or the abutment of the bridge may be built around the piles of the structure which is being renewed. The facility with which concrete may be strengthened by the judicious use of iron or steel embedded in it is of great value.

On account of the plastic nature of the material, intricate and irregular shapes may be built almost as easy as simple ones, the only difference of moment being that of the cost of constructing the form or mold. Skew arches and abutments and other like structures, which, if built of cut stone, are very expensive, are readily built of concrete.

Concrete, properly made of suitable materials, is probably fully as durable as the ordinary stone masonry. It has been used for many years in other countries and has proven satisfactory in this respect. Looks are merely a question of personal opinion, but, in the writer's opinion, concrete work presents a more pleasing appearance than stone masonry. Lastly, it may be stated that in the central part of the United States, at least, with the prevailing prices of labor and material, concrete masonry may be built for considerably less per cubic yard than the corresponding class of stone masonry. The cost of concrete bridge and culvert construction in any locality may be estimated roughly from a few general figures given below. These figures are deductions from the actual cost of a large volume of work. The cost of labor on one cubic yard of concrete will average about 90 per cent of the price paid per day for labor. This covers the cost of unloading all concrete materials and tools, building concrete mixing platforms and runways, mixing by hand, and placing and tamping. It does not include the cost of the forms, cost of excavating, nor the cost of train

ITEMS TO BE USED AS A BASIS FOR ESTIMATING THE COST OF A CUBIC YARD OF CONCRETE OF VARIOUS PROPORTIONS.

Proportion of Materials.	Cost of Labor, Mixing and Placing per Cubic Yard.	Cost of Forms per Cubic Yard (where Forms are required).	Materials per Cubic Yard.		
			Cement.	Sand	Broken Stone.
1 part of natural cement to 1½ parts sand to 4 parts broken stone....	90 per cent of the amount paid per day for labor.	From 35 cents to 85 cents per cubic yard.	1¼ bbls.	0.35 cu. yd.	0.95 cu. yd.
1 part Portland cement to 2 parts sand to 5 parts broken stone....	"	"	12 bbls.	"	"
1 part Portland cement to 3 parts sand to 7½ parts broken stone....	"	"	0.9 bbls.	"	"

service. As an illustration, where \$1.50 per day is being paid for labor, the cost of labor per cubic yard of concrete should average about \$1.35 for all classes of concrete work. Work inside of the forms will cost more, and work building the footings less. The cement required per cubic yard of concrete will average about as shown in the table.

In conclusion, the writer wishes to say that he does not expect that the engineer who is familiar with concrete construction will learn anything new from this paper nor that he will agree with all of its details. The foregoing is the result of the experience of the writer, gained in the use of concrete on a railroad which has gone into its use on a large scale, and is the expression of his individual views. He feels that concrete is a very valuable and important form of masonry and adapted to a wide range of uses; that its use requires constant study of its characteristics, and

constant care and watchfulness in its construction; that there is much to learn as to its proper and best use, and that the question of proportions to be used requires careful study. Many errors are and will be made in its use; we only learn how far outside of the beaten paths we can go by these mistakes, but concrete should not be condemned as a whole because of minor mistakes. These may be traced to defective workmanship or materials or an improper understanding of characteristics.

### COMPRESSION TESTS OF CONCRETE CUBES, FOR THE CITY OF CLEVELAND, OHIO.

These tests were made with the United States testing machine at the Watertown Arsenal, Massachusetts, and are given here as a matter of interest:

The blocks numbered from 25 to 32, inclusive, are made of 1 part, by measure, of vulcanite Portland cement, 2 parts of slag dust, and 4 parts of crushed slag.

The blocks numbered from 41 to 48, inclusive, are made of 1 part, by measure, of vulcanite Portland cement, 2 parts of lake sand, and 4 parts of broken Kelley Island limestone.

The cement and fine material were first mixed dry by a thorough shoveling, and just enough water was added so as to make the water flush when the mixture was pounded or squeezed. The stone or slag was wetted sufficiently so that it did not absorb any of the water from the cement and was then added to the mixture of cement and fine material, and the whole thoroughly shoveled over. It was then rammed into wooden boxes, in layers of about 2 inches in thickness, sufficient to flush the water to the surface of each layer.

Marks, 32. Sectional area, 144.60 square inches. Gauged length, 5".

Applied loads.		In gauged length.		Remarks.
Total.	Per square inch.	Compression.	Set.	
Pounds.	Pounds.	Inch.	Inch.	
14,460	100	0.	0.	Initial load.
28,920	200	.0001	.....	
57,840	400	.0004	.....	
86,760	600	.0007	.....	
115,680	800	.0011	.....	
144,600	1,000	.0014	.0001	
173,520	1,200	.0018	.....	
202,440	1,400	.0022	.....	
231,360	1,600	.0027	.....	
260,280	1,800	.0033	.....	
289,200	2,000	.0039	.0007	
318,120	2,200	.0044	.....	
347,040	2,400	.0052	.....	
375,960	2,600	.0061	.....	
404,880	2,800	.0075	.....	
433,800	3,000	.0090	.0028	First crack. Ultimate strength.
465,000	.....	.....	.....	
467,700	3,234	.....	.....	

Marks, 48. Sectional area, 145.32 square inches. Gauged length, 5".

Applied loads.		In gauged length.		Remarks.
Total.	Per square inch.	Compression.	Set.	
Pounds.	Pounds.	Inch.	Inch.	
14,532	100	0.	0.	Initial load.
29,064	200	.0001	.....	
58,128	400	.0004	.....	
87,192	600	.0007	.....	
116,256	800	.0011	.....	
145,320	1,000	.0015	.0001	
174,384	1,200	.0019	.....	
203,448	1,400	.0022	.....	
232,512	1,600	.0028	.....	
261,576	1,800	.0032	.....	
290,640	2,000	.0037	.0007	
319,704	2,200	.0041	.....	
348,768	2,400	.0046	.....	
377,832	2,600	.0053	.....	
406,896	2,800	.0061	.....	
435,960	3,000	.0069	.0017	First crack. Ultimate strength.
506,000	.....	.....	.....	
511,500	3,530	.....	.....	

Marks, 44. Sectional area, 146.65 square inches. Gauged length, 5".

Applied loads.		In gauged length.		Remarks.
Total.	Per square inch.	Compression.	Set.	
Pounds.	Pounds.	Inch.	Inch.	
14,665	100	0.	0.	Initial load.
29,330	200	.0001	.....	
58,660	400	.0002	.....	
87,990	600	.0006	.....	
117,320	800	.0010	.....	
146,650	1,000	.0013	.0001	
175,980	1,200	.0019	.....	
205,310	1,400	.0022	.....	
234,640	1,600	.0028	.....	
263,970	1,800	.0032	.....	
293,300	2,000	.0036	.0006	
322,630	2,200	.0040	.....	
351,960	2,400	.0043	.....	
381,290	2,600	.0045	.....	
410,620	2,800	.0050	.....	
439,950	3,000	.0054	.0008	First crack.
469,280	3,200	.0057	.....	
498,610	3,400	.0063	.....	Ultimate strength.
527,940	3,600	.0072	.....	
557,270	3,800	.0081	.....	
582,000	.....	.....	.....	
586,600	4,000	.0091	.0007	
606,500	4,136	.....	.....	

Marks, 28. Sectional area, 146.28 square inches. Gauged length, 5".

Applied loads.		In gauged length.		Remarks.
Total.	Per square inch.	Compression.	Set.	
Pounds.	Pounds.	Inch.	Inch.	
14,628	100	0.	0.	Initial load.
29,256	200	.0001	.....	
58,512	400	.0002	.....	
87,768	600	.0003	.....	
117,024	800	.0008	.....	
146,280	1,000	.0012	.0001	
175,536	1,200	.0015	.....	
204,792	1,400	.0018	.....	
234,048	1,600	.0022	.....	
263,304	1,800	.0026	.....	
292,560	2,000	.0031	.0003	
321,816	2,200	.0036	.....	
351,072	2,400	.0041	.....	
380,328	2,600	.0046	.....	
409,584	2,800	.0053	.....	
438,840	3,000	.0062	.0012	
468,096	3,200	.0076	.....	
497,352	3,400	.0088	.....	
526,608	3,600	.0106	.....	Ultimate strength.
555,400	3,797	.....	.....	

### CUBES TESTED APRIL 30, 1900.

[Age, 52 days. 3 days in air, 28 days in water, then 21 days in air.]

No. of test.	Marks.	Weight.		Dimensions.			Sectional area.	First crack.	Ultimate strength.	
		Total.	Per cubic foot.	Height.	Compressed surface.				Total.	Per square inch.
					Inches	Inches				
9933	29	135½	133.1	12.04	12.10	12.10	146.41	489,200	489,200	3,341
9934	30	134½	134.0	11.88	12.10	12.09	146.29	418,000	445,600	3,046
9935	31	133	131.6	12.00	12.09	12.04	145.56	435,000	439,000	3,016
9936	32	134¼	133.2	12.04	11.98	12.07	144.60	465,000	467,700	3,234
9937	45	147	145.2	12.04	12.09	12.02	145.32	513,000	549,800	3,783
9938	46	146½	145.6	11.95	12.07	12.05	145.44	498,000	509,900	3,506
9939	47	147	144.7	12.08	11.98	12.13	145.32	534,000	536,700	3,693
9940	48	147	145.2	12.04	12.02	12.09	145.32	506,000	511,500	3,530

### CUBES TESTED JUNE 2, 1900.

[Age, 85 days. 3 days in air, 58 days in water, then 24 days in air.]

10247	25	138½	136.0	12.10	12.00	12.12	145.44	572,000	581,000	3,995
10248	26	137	134.8	12.16	12.15	11.89	144.46	579,900	579,900	4,014
10249	27	142	135.8	12.18	12.21	12.15	148.35	568,000	612,500	4,129
10250	28	138	134.4	12.13	12.11	12.08	146.28	555,400	555,400	3,797
10251	41	145¼	146.9	11.95	12.10	11.84	143.26	558,000	612,000	4,273
10252	42	145½	145.4	11.90	11.99	12.12	145.32	567,000	610,700	4,262
10253	43	147½	147.0	11.90	11.99	12.15	145.68	594,000	660,500	4,534
10254	44	147½	146.1	11.90	12.10	12.12	146.65	582,000	606,500	4,136

Mr. H. G. Kelley (Minneapolis & St. Louis):—The Committee, in presenting this report, considers it unnecessary to read the report on account of its length, but we desire to read the conclusions which we present to the Association and the resolutions which we recommend to be passed. There are a number of details in the description of various classes of masonry work to which the individual members of the Committee are not willing to subscribe entirely, although in its general form they have expressed their willingness to sign this report. I will read the first resolution, in which we have made a slight change in the definition of "masonry" since the report has been printed:

"Resolved, That the following definition be adopted by this Association as a comprehensive definition to cover any kind of masonry, and with the further recommendation that in usual practice the word "masonry" be qualified by some proper term to more particularly describe the kind of masonry under consideration:

"Masonry, in its widest sense, includes all constructions of stone or kindred substitute materials, in which the separate pieces are either placed together, with or without cementing material to join them; or, when not separately placed, are encased in a matrix of cementing material."

The second resolution is changed to read as follows:

"Resolved, That this Association approves as good practice that railroad companies prepare and use specifications complete in themselves for all kinds of masonry, to be in such form that they may be attached to, and form part of, specifications for other railroad construction when desirable."

President Kittredge:—Gentlemen, this report is before you for consideration. You will find on pages 11 and 12 the conclusions at which the Committee have arrived, bearing in mind the changes which have just been suggested.

Mr. J. H. Abbott (Baltimore & Ohio):—I ask for information. Do I understand correctly that the Committee recommends that mortar may be used which has been mixed an hour?

Mr. Kelley:—That is the consensus of reports received from the railroads reporting to us, that one hour be the extreme limit after the mixing of the mortar. If it is allowed to stand over an hour it must be condemned, whether it has set or not.

Mr. Abbott:—In using natural Louisville cement on the Henderson bridge we found it necessary to condemn any mortar that

had been standing over twenty minutes, and under the condition surrounding us there I should not like to see the mortar go in after standing 20 minutes. Take the Sandusky Portland cement, and similar conditions exist in regard to that. I would not like to have it stand an hour. I do not think that is good practice.

Mr. Kelley:—I think the Committee entirely agrees with the remarks made, but in view of the specifications that were received, one hour was placed as the limit, and then that was modified by saying: "And always before it shall have commenced to set." My experience with the Louisville cement you mention would lead me to cut it out after 20 minutes, and sometimes before.

President Kittredge:—Can the Committee cite any instances, and under what conditions, any cement could have stood nearly an hour, and yet be safe to use? Were any cases cited?

Mr. Kelley:—No special case was cited, as I understand it.

President Kittredge:—It would be interesting to know under what conditions the period of one hour could be reached.

Mr. Kelley:—The gentleman who wrote that portion of the report is not here to-day, but it is understood to have been the consensus of opinion received by him in correspondence.

Prof. W. D. Taylor (University of Wisconsin):—I have read the report carefully, and have several points I would like to call the attention of the Association to for such action as it chooses to take. In the first place, the Committee uses two terms for the kind of cement in use in this country. Throughout the report they call one the "natural hydraulic cement" and the other they simply call "Portland cement." I think we might omit the word "hydraulic" and designate the cements as "natural" and "Portland."

The next thing I would offer would be to insert in the report under the head of first-class masonry the words, "except the coping," so that the sentence will read: "No course shall be less than 12 nor more than 30 inches in thickness, and, except the coping, the thickness of any course shall not exceed the course below it."

Under the heading of "Backing" for first-class masonry, it says: "The spaces between the large stones shall not be over six inches in width and shall be thoroughly filled with small stones and spalls laid flat," etc. I suggest that there be appended to that sen-

tence the following words: "And all spaces flushed full with mortar or good cement grout." At the end of the same paragraph, following the words, "In cases approved by the engineer, satisfactory Portland cement concrete," I suggest that the words, "with or without larger stones embedded in the concrete," be inserted, the sentence to read: "In cases approved by the engineer, satisfactory Portland cement concrete, with or without large stones embedded in the concrete, may be used for backing." Under the head of "Mixing," I would suggest, where it says, "until the stones are covered with the mortar and all voids completely filled," that we use the word "practically." We do not get the voids completely filled. Where the Committee recommends the use of concrete for different purposes, it says, "a good mixture of 1 part Portland cement, 4 parts good sand and 8 parts broken stone," etc., I would suggest that the figure 3 be used for the figure 4, and that the figures 8 to 10 be substituted for 8. Mr. Rafter's experiments, conducted in the office of the State Engineer of New York, would seem to show that the most economical concrete is not made by making the mortar lean in cement, but rather by making the concrete lean in mortar.

Mr. Abbott:—Before we leave this mortar subject, I would move that the words, "within one hour after mixing," be stricken out, so that it shall read, "All to be very carefully measured and mixed," striking out the words "within one hour after mixing."

Mr. Kelley:—The Committee will be pleased to accept that.

President Kittredge:—Will the Committee take cognizance of the remarks of Mr. Taylor in regard to inserting the words "except coping?"

Mr. Kelley:—Yes, sir.

President Kittredge:—And his other remarks on the subject of "Backing," on page 4? If the Committee is willing to accept these without further discussion I think we will save time.

Mr. Taylor:—One or two of these suggestions, I think, I will vote against myself.

President Kittredge:—If there are any suggestions, even though the Committee were very willing to incorporate them in their report, if there are any questions you would like to discuss, it would be decidedly to the benefit of the Association to have

them discussed. If you will let us finish up the part Mr. Taylor has brought up, we will make progress. In the "Backing for First-Class Masonry," I understand Mr. Taylor wants some discussion. He wants added "or good cement grout."

Mr. Taylor:—But I will vote against it.

Mr. D. W. Lum (Southern Railway):—I would object to the use of the word "grout" in that connection.

Mr. E. H. Lee (Chicago & Western Indiana):—It might be well to have an expression of the views of the members of the Association regarding the use of concrete in place of the old method of using spalls and flushing mortar. It seems to be a practice which is growing among engineers in backing up first-class masonry to substitute the use of concrete in filling the larger spaces instead of using spalls and flushing mortar or using spalls and using grout, as has sometimes been done. I would be glad to hear an expression from some other members who have had experience in the construction of this particular type of masonry in regard to this point.

Mr. Kelley:—The Committee are willing to accept the insertion of the words "except coping," under the head "First-Class Masonry." They are also willing to accept "large stones embedded in concrete," but do not desire to accept, without the instruction of the Association, the words, "or good cement grout." The Committee, I think, are a unit on cutting out "cement grout" entirely in first-class masonry construction.

Prof. W. D. Pence (Purdue University):—It seems to me the question of using grout is quite largely a matter of the amount of water which should be added to the mortar. That is not the only distinction always, of course, but if an engineer should occasionally think it is desirable to have mortar in such shape that it will flow more readily, that is a matter of detail, and the specifications themselves should not mention the grout. I think it better to omit it.

Mr. E. E. Hart (New York, Chicago & St. Louis):—During the present winter we have been taking down some 70 and 80 foot piers built on the New York, Chicago & St. Louis, at Girard, Pa., and from all appearances these piers were grouted; that is, the spaces between the cut stones were filled with spalls and grout. While we did not find any large spaces in the grout, we did find

a great deal of dampness and frost in the grout, which, I think, led to the disintegration and failure of the piers. From what I saw there it would seem better policy to use mortar.

Mr. J. A. Atwood (Pittsburg & Lake Erie):—I would like to express my preference for the use of concrete for the heart of first-class masonry walls over the use of spalls and grout. I think the former is first-class practice and the latter is crude.

Mr. A. S. Markley (Chicago & Eastern Illinois):—If the grout is properly made and used, I do not see how there could be any voids whatever in the masonry. The care in grouting a pier depends entirely on those in charge of the work. Each course should be grouted before a second one is started. Those in charge of grouting can watch through the voids and see whether the grout is properly distributing itself throughout them, and when all the voids are filled the grout of course will come to the surface. If proper care is taken the grouts will make the masonry solid.

President Kittredge:—It occurs to me the discussion here is under "First-Class Masonry."

Mr. Hunter McDonald (Nashville, Chattanooga & St. Louis):—I know of an instance where 300 barrels of grout were poured into one pier, and it all ran out into the river below the water level.

Prof. J. B. Johnson (University of Wisconsin):—I have known of a number of very serious differences, which have been taken into the courts for settlement, in regard to what is meant by "one of cement and three of sand." I have been searching carefully through this report to find out what is meant, and I cannot find it. Of course, the contractor saves about a third of his cement, if he is allowed to fluff it out, take it from sacks and dump it out loosely; he can make it fill about 50 per cent more than it did in the original package. It seems to me it is very unwise for engineers to continue the practice to specify so much cement for so much sand and not find out what that means. The difference in meaning is nearly 50 per cent of the cement. The contractor, of course, always dumps his cement out loosely and measures it up in shovels, wheelbarrows or something, and if the engineer means it to be so, of course it is all right—he writes the specifications with that intention; but many engineers write their specifications expecting the cement will be measured in the

original packages, but they do not say so. Then there is an open controversy. I would like to know what the practice is in this Association, and whether or not that should not be defined. And this applies, in fact, to all the specifications in the use of cement that I am familiar with. I almost never see a specification wherein this is properly defined.

Mr. Kelley:—We wish to call the attention of the Association to the fact that this is merely an outline specification for cement concrete. We have taken all the information we could; it has been digested as well as possible, and it has been presented simply as an outline, and discussion is something that we wished on the subject; but it is merely an outline of what specifications for cement concrete should be, and it is not offered to the Association in any way as a permanent specification.

Mr. McDonald:—I move that in regard to the composition of mortar, the words "by volume" be substituted after the words "either one part;" also that in the fourth line from the bottom the words "three to four" be put in after "cement," making it read, "one part by volume of approved Portland cement to three to four parts of good, sharp sand."

Prof. Johnson:—Would you not define what you mean by one part or volume to four parts of sand?

Mr. McDonald:—I mean it shall be measured after taking out of the package, loose.

Prof. Johnson:—Then should not that be defined, "One part by volume measured loose?"

Mr. McDonald:—I will accept the amendment. My object is to get it in the shape that it is usually handled by the men who use it.

President Kittredge:—This discussion is really for the benefit of the Committee, and is not being handled in the way of motions and instructions from the Association. The Committee really presents a very small amount of conclusions which the Association should act upon by vote. The rest of the report is an outline of specifications submitted by the Committee, on which they desire discussion and instructions, and not sent here for final action. Therefore, if Mr. McDonald will make his remarks in the way of a suggestion to the Committee instead of a motion, it will be proper.

Mr. McDonald:—I will very cheerfully change it from a motion to a suggestion.

Mr. Garrett Davis (Burlington, Cedar Rapids & Northern):—As I understand the case, Prof. Johnson refers to being absolutely accurate, as near as possible, in testing. In practice, if our directions call for one barrel of cement to, say, two barrels of sand, or six barrels of gravel, we measure the barrels of gravel. It is loose, it is true. We have a barrel of cement as it is packed, and we have a number of parts of gravel called for, loose, but that is in favor of the increase of strength in the mixture.

Prof. Johnson:—Now, this illustrates my point exactly. One of the last two speakers claims that the practice is to measure cement loose, and the other claims that the practice is to measure it in the original package. I submit if that is not proof of the proposition I present to you, that unless the volume is defined, whether loose or in the original package, the contractor does not know what the engineer means, and the engineer sometimes does not know what he means himself.

Mr. Kelley:—I think Prof. Johnson's remarks are very well timed. The question of volume is an extremely uncertain one as it appears in most specifications. You can take a sack of cement and pour it out so it will fluff up and make quite a percentage of increase in volume. It would be impossible to measure that loose, fluffed cement and get any results. It would vary with each individual sack, and the strength of the man himself. In my own personal specifications I say "barrel" of each, and then I have them measured in the field, a certain definite measure. But I would regret very much to see the word "loose" go into any specification coming from the Association. It should be either in the original package or given some more definite term indicating the volume intended to go in.

Prof. Johnson:—I want to clinch a nail when it is driven. Suppose a contractor buys his cement in sacks and he has to put it into a barrel in order to fulfill the specifications. He can fluff it a great deal better in the barrel than if it is spread out. Therefore, it seems to me that still does not satisfy, and I do not believe anything will satisfy, if you wish cement measured in the original package, except to say "by volume, the cement to be measured in the original package." You can fill that original

package after the cement has been emptied. You can fill it with sand, stone or gravel, or what-not, and you are all right, but unless the cement is taken in the original package, as it is delivered on the work, I do not know of any way in which you can get that volume measured.

Mr. G. M. Walker, Jr. (Kansas City Belt Railway):—We have used a specification, so many cubic feet of sand, so many cubic feet of gravel and so many pounds of cement of different kinds. A barrel of Portland cement of a certain brand weighs a certain amount; a barrel of natural cement weighs a certain amount, so that whether we get it in barrels or get it in bags, those bags are all weighed, and weigh about the same. I think we could get a better specification than specifying by bulk, and will get the same thing Prof. Johnson claims should be in the specification.

Mr. Davis:—I wish to say that all sacks are parts of a barrel; three sacks natural or four sacks Portland are a barrel when it is received in sacks, so it is precisely the same thing.

Mr. Lee:—In confirmation of what the last speaker has just stated, it may be said that in one of the most expensive cases with which the speaker is acquainted, and under which, perhaps, 150,000 yards of concrete have been put in, the specifications covered this point in precisely that manner. The weight of the cubic foot of cement was specified, in the case of Portland, at 100 pounds. This, perhaps, would work some injustice to the manufacturers of certain kinds of Portland cement, which do not weigh quite that much. But after the brand which is to be used has been determined, it would seem very easy to specify the exact weight which should be considered a cubic foot. Of course it is not possible to weigh every sack or every barrel that is used. This particular clause in the specifications, as is the case with most other clauses, is simply a standard, a rule which is to be used, in case of disagreement. The ordinary practice is to use the material, dumping it out of the package in which it comes.

Mr. A. R. Raymer (Pittsburg & Lake Erie):—Our road has recently gone into the use of concrete extensively. We are now using concrete construction for culverts up to 16, 18 and 20 feet, with arch covering, and we have been to some trouble to get specifications to cover the different conditions we met, and we

find we come short in some points, particularly the points now before the house on the question of the proper proportion of mixing cement with sand. We have different sorts of sand. Probably the conditions are similar to those throughout the country. We find that the result depends on the nature of the sand; where this sand is uniform in size, more cement is needed than in cases where the sizes of the particles vary. We have about come to the conclusion that it is necessary to make a test in each case to determine the amount of voids, and then add the amount of sand which will fill these voids with a certain percentage of excess. The amount we have not yet determined. The mixture determined in that way will cover the case exactly and will cut out the necessity for measurements by bulk, by weight, or any other way, and will cover the varieties of sand. Our concrete will be made up in the same way; we have gravel of different sizes and also crushed stone. To say that we should use five parts, four parts or six parts does not mean much. The proportion depends on whether the particles of stone are of the same size or vary in size.

Prof. Johnson:—Excuse me for speaking so much, but this is in my line. I do not know of anything more deceptive in the matter of mixing mortar than to take the criterion that has just been mentioned of measuring the voids. If you take a fine sand, the voids are about one-third. Take clean, coarse sand and the voids are one-third; and you can better afford to pay \$6 a yard for the coarse sand than \$1 a yard for the fine sand, if you use a given proportion of three to one and wish a particular strength. Here is something usually overlooked. It is commonly supposed that the function of the cement is simply to fill the voids. That is a great mistake. The function of the cement is to coat every grain of sand and to fill the voids. Every grain of sand must be surrounded with a coating of cement, and then the voids also must be filled. If you will do a little mathematical work you will find that the surface to be coated in a cubic foot of spheres varies inversely with the diameter of the spheres. So that with sand grains half as large there is twice as much surface to be coated; with sand grains a third as large there is three times as much surface to be coated, and the voids still remain the same. So that even mixing fine

sand with coarse sand for the purpose of reducing the voids does not help you any, and you always lose by it. The coarser the sand the better, even though the grains all be coarse and of an even size, and there is no limit I know of to that rule until you get to the size of marbles. The coarser the sand, the stronger, and it has been fully demonstrated for a given strength you could better afford to pay \$6 a yard for sand varying from the size of a pea down to one-fourth that size, than you could to use fine, ordinary sand at \$1. So that must be taken into account—the coarser the better. But I still wish to say I am not convinced that the specification by barrel satisfies the case when the cement is delivered in sacks, because the contractor might very well say: "I do not know how many sacks make a barrel." He takes the sacks and fills up a barrel from these sacks, and I do not see but that he has a very good claim. He fills a barrel of cement and determines how many sacks are required to fill a barrel. There are two sides to this. The engineer in some cases can have it all his own way. Then, of course, it would be plain sailing. But the contractor usually has something to say after the contract is signed.

Prof. Pence:—There are two points we should have in mind. One is that a number of us are thinking about work done by contract, in which we must have definite specifications, and the other, work done by the company's laborers, where we have an opportunity to make requisition for the materials we need, and to supervise the work and change the specifications in the progress of the work if we wish to. We have been thinking of sand as a somewhat definite material. As a matter of fact, it makes a good deal of difference as to the amount of moisture that is in the sand, and as to the amount it will expand from its packed state to the state you use it in in the mortar box. There is also considerable variation in most cases as to the amount of moisture in the sand, although I suppose on most large jobs, such as the construction of retaining walls for track elevation, you have practically a uniform product furnished.

Mr. Atwood:—I would like to ask Prof. Johnson if, in the following case, there would not be some difference in the use of cement. Suppose we use gravel, for instance—it is rather an extreme case—of the size of a marble, half an inch in diam-

eter, and fill the voids full of cement alone. That would take a certain amount of cement. Now, if you add sand and fill the voids, you have got the same bulk, but you are going to have less cement. Carrying that on down, and it seems to me it carries out the idea that the use of a proper amount of sand is going to reduce the amount of cement to be used.

Prof. Johnson:—The tests have been very thoroughly made up to grains nearly the size of a pea, and up to that limit the greatest strength is attained with four-fifths or five-sixths of the coarse and one-fifth of a fine grade. To obtain the benefits of mixed sizes of sand grains, a little fine sand may be mixed with a very coarse sand, but any coarse sand found in nature will always have more than enough fine sand with it to give this maximum benefit.

Mr. Atwood:—The general idea was to use sand as it comes to us in commercial ways, and also gravel, and they vary from a certain fineness to a certain coarseness, and that the use of gravel and sand in these proportions reduces the amount of cement that is necessary to use; and it seems to me the argument outlined in the case is that by reducing the amount of cement in this way, we still get first-class concrete. We do not have to pay for the cement.

Prof. C. F. Allen (Massachusetts Institute of Technology):—It seems to me part of the question is as to how much you can do with a barrel of cement. If you take your marbles, in one experiment, and fill with cement, you get a certain bulk. If, instead of filling all the voids with cement, you fill part of the voids with sand, you will get the same bulk and have some cement left over to make another bulk, and with one barrel of cement you will certainly get a larger bulk if you do have coarse grains with finer grains filling the voids between them. I have not kept up lately with the experiments upon mixtures of sand and cement, but I have it very strongly in mind that some experiments have indicated that sharp sand—a mixture with sharp, fine sand and cement—give a stronger mixture than coarse sand and cement. I feel reasonably positive that some experiments have indicated that. I cannot say that other experiments have not indicated the other thing, but I do not feel sure at the present time that it is demonstrated beyond question that the coarser the sand is, the

better. But on the original proposition, as to what you can do with a barrel of cement, I do not see how you are going to escape the conclusion that with the large particles and the small particles filling the voids, a barrel of cement will go farther than it will with the coarse particles alone.

Mr. Atwood:—It is probably improper for the Committee to recommend a proportion of cement, sand and stone to be used, because of the character of sand and stone used, also because of the character of the work for which the concrete is being made. If they wish to recommend a proportion, they should recommend along with that proportion the character of the work for which the cement is designed.

Mr. McDonald:—I think it would be very much in order for the Committee to consider and tell the Association what is a good sand. I have recently had an experience in being called to look over some concrete that did not appear to be what it should have been. It was laid in freezing weather. No precautions were taken against that; but on examining the sand I found that 30 per cent of it would pass through a No. 50 sieve; the rest of it was fairly coarse. I tested the cement, and in seven days it gave 350 pounds. The sand mixed up in proportion of three to one gave less than 40 pounds. That sand has been in use in a certain community I know of for years, in its present shape, and I am satisfied that a great many would undertake to use it without screening the fine part out, and I consider it very dangerous practice. I attribute the fact that this concrete failed to the very fact that the voids in the same were filled with these very small particles of sand, and that the cement could not enter. When cement is added to that kind of sand, the volume is materially increased. I would like to submit for consideration crushed stone as a substitute for sand. I have seen some experiments made where it gave as good results as coarse sand, and there are some places where sand cannot be obtained, while crushed stone can.

Mr. Taylor:—Do you not mean pulverized, rather than crushed?

Mr. McDonald:—Well, sand that would pass through a No. 4 screen and be caught on a No. 50.

Prof. Pence:—In the report of the Committee there is a very valuable article by Mr. Rogers. I find reference to expan-

sion and contraction of the concrete. I take it Mr. Rogers' contribution is not open for discussion, but I should like to make inquiry in regard to the views of the members as to the expansion or contraction of long concrete walls, such as are used in track elevation. The first two sentences in the paragraph headed "Expansion and Contraction" is what I refer to: "Concrete expands and contracts with variations of temperature at about the same rate as iron, and allowance should be made for this in building long walls." Some experiments recently made under the speaker's direction show that there is a material difference between the expansion of structural steel and concrete. The coefficient usually taken for structural steel is .0000065, while that of concrete is .0000055. The next sentence also applies to what I have in mind: "In ordinary abutments or culverts, where the wall is not over 60 feet long, the writer has not been in the habit of making any allowance; but for greater lengths he is in favor of dividing the wall into about 40-foot sections." I have been credibly informed that in Chicago, in the construction of walls of small section, it was found in the course of one season cracks developed in 60-foot sections; so that for a light wall the length should possibly be 30 feet instead of a greater amount.

Mr. O. D. Richards (Ann Arbor):—Referring to the use of bank gravel not screened, I would like to ask the Committee if they have ever turned any arches or know of any being turned with such material, and if so what the results were? We have a good quality of gravel, and I desire to get all the information possible on the subject.

Mr. Davis:—I can answer the gentleman, so far as my experience goes. We have some arches, 10 feet up to 20 feet. We preferably use three or four rings of brick in the arch alone; all the rest is concrete. We have some made of the concrete, but the principal advantage of using the brick is the economy of putting it in to avoid tamping the ring of concrete. In this report, the Committee did not recommend the use of natural gravel. In Northern Iowa and Minnesota we have numerous pits of pretty good gravel, except that it contains quite a large proportion of fine sand. It would doubtless be better if it were screened out. With us it is a matter of expense. If the sand was screened out we would not have very much gravel left, besides the expense of handling. If it has clay in it (and it frequently has), we wash

it out. In all of our concrete we wash the gravel; and our experience with this gravel in concrete has been entirely satisfactory. We use both natural and Portland cement. The natural cement is below ground and all above ground is Portland, and we have used a great many yards of it without any ill effects at all.

President Kittredge:—I understand Mr. Davis refers to the use of gravel instead of broken stone.

Mr. Davis:—Yes, sir. We have not any stone within 200 miles that we could use. As to the matter of expansion that was referred to, I would be in favor of making the expansion joint every 30 feet. We have in one or two instances made a long retaining wall, and we found that it cracked, so that in the future, if I put in a plain face wall, without an angle, if it was going to exceed 30 feet, I would provide a joint.

Mr. A. C. Dennis (Canadian Pacific):—I would like to inquire if concrete made of gravel instead of broken stone is suitable for tunnel lining or arches of large size—how it compares with the strength of concrete made from broken stone?

Mr. Davis:—I would simply say that some men that I have discussed the matter with favor gravel if it is washed clean and free of any clay or particles that adhere to the stone. In crushed limestone you have a rough surface, with small particles adhering to that stone, just about to be detached, but still adhering to it. I think experience has shown that gravel concrete is stronger than that kind of stone concrete. Rock or granite that broke with a clean fracture would doubtless be preferable.

President Kittredge:—If there is no other discussion on the report, we will pass to the conclusions of the Committee, and we will consider that the first resolution is now before you. As amended, this resolution reads:

“Resolved, That the following definition be adopted by this Association as a comprehensive definition to cover any kind of masonry, and with the further recommendation that in usual practice the word ‘masonry’ be qualified by some proper term to more particularly describe the kind of masonry under consideration.

“Masonry, in its widest sense, includes all constructions of stone, or kindred substitute materials in which the separate pieces are either placed together, with or without cementing material to join them, or when not separately placed are encased in a matrix of cementing material.”

It will be considered that that is before the house. Any discussion on that resolution?

Mr. C. Lewis (Baltimore & Ohio):—I regret that I have not been able to discuss this more fully with the Committee. I would like to inquire whether pilasters, etc., which are cast whole out of mortar, should not also be considered as masonry or stone. Artificial building blocks are being made of mortar and concrete, and when those blocks are laid they could be covered by this definition, because they could be considered as substitutes for stone. Might the definition not be so amended as to include columns and pilasters cast complete, or should such castings not be considered as masonry?

Mr. Taylor:—I would like to ask the Committee whether or not they mean to include riprap. This definition of masonry would certainly be taken to include riprap.

Mr. Kelley:—No; the Committee does not intend to include riprap.

Mr. Abbott:—I do not know whether I quite understand whether an amendment will be necessary to include these casts, but it seems to me that in the definition of masonry the casts might be considered as material, rather than go back to the stage of manufacturing and conceive of the material which goes to make them up; that is, they become masonry after we take them and begin to form our columns and buildings; they are like stone then. I don't see that it is necessary to go back to nature and determine how the rock and the stone were formed to include it in our definition of masonry.

(The resolution as amended and read was adopted.)

President Kittredge:—The second resolution is that "This Association recommends as good practice that railroad companies prepare and use specifications complete in themselves for all kinds of masonry, to be in such form that they may be attached to, and form part of, specifications and contracts for other railroad construction when desirable."

Mr. Kelley:—I would like to explain the reason the Committee has presented this resolution. A number of replies for specifications of masonry were received from companies stating that they did not contract their work, and therefore had no specifications; that the men knew precisely what they wanted and did

the work to suit them. The Committee held, whether the work was done by the railroad company's force or was done by contract, that a specification was necessary to know the class of work that was to be done and to insure its being done in the way the chief engineer or officer in charge of the work desired, and therefore we made this resolution.

(The resolution was adopted.)

Mr. McDonald:—I move the report be adopted as a whole.

(The motion was carried.)

Mr. J. P. Snow (Boston & Maine—by letter):—This excellent and conservative report leaves little to criticise as to specifications for stone masonry. A few thoughts occur to the writer which are put forth merely as suggested additions, rather than as changes. They may have been considered by the Committee and rejected as not desirable.

The length of stretchers should be a ratio of their rise; from two to five and one-half is reasonable. If too short, they appear like blind headers and do not make proper bond, and if too long, a movement of the wall is liable to break them. The bond also should be a function of the rise. Its proper minimum should be a length of joint that will hold strong enough to nearly break the stone. It is better that the joint should slip if a strain occurs than that the stone should break, but we want all the strength that can be obtained with safety; two-thirds the rise is suggested as a good, practical minimum. In random or broken course work or irregular rubble masonry the limit of bond should apply to the thinner of the two stones concerned.

The report prohibits hammering on any stone after it is set. This requirement seems unnecessarily severe. In order to get good work, irregularities and high spots must sometimes be removed and the face pitched to a line after a stone is laid. Hand-pointing should not injure the setting of the stone; heavy hammering may well be proscribed.

In second-class work with broken courses the minimum thickness of levelers in the face of the work should be prescribed; three or four inches is recommended. If this is not specified, levelers so thin will be used that they will be no better than pinners.

The report allows rather too much space between headers in second-class work, while for the first and third classes the

requirements are perhaps rather severe. The necessity for headers is about equal in all classes of work. They should be, in 24-inch work, not more than 12 to 14 feet apart in any course or for any rise, and at least one-eighth of the area of the face and back of a wall should be occupied by headers. Joints broken on headers or levelers should not be allowed.

A very common class of work, usually called rubble in granitic regions, not specified in the report, may be described as follows: The work shall be built of sound quarried rubble laid without pinnars in the face. The beds of the stones may slope lengthways of the wall, but not across it. Thin edges of stone used in the face shall be broken off so as to be not less than 4 inches thick. No more than three stones shall be contiguous to any one vertical joint. The backing shall be the same class of stone as the face, except that pinnars may be used under the stones, provided the whole height of the blocking is made up with a single stone; pinnars on pinnars will not be allowed. All stones shall have a width at least equal to their rise, and they shall break joints not less than two-thirds the rise of the thinnest stone bonded.

At least one-eighth of the area of the face and back of the wall shall be occupied by headers, so placed as to thoroughly tie the wall together, and no joints shall occur on or under headers or levelers.

More stress might well be laid on building the work solidly in mortar than is done in the report. Dry work is frequently injured by the stones breaking or tending to roll, due to imperfect support on stones below. This is especially liable to occur when the work carries a heavy load. A stone naturally bears on three points; it can be pinned up so as to get partial bearings on more points, but if wedged up too tight at any one it will be raised from all other bearings except two. It follows that when a heavy load comes upon a stone so supported, it is very liable to break, whereas if it is laid solid in mortar it will have a bearing all over its bed and be much less liable to break. In dry work also, and that where a little mortar is used to plaster over a mass of dry filling, the bearings of many of the stones must necessarily be on pinnars; if these are thin, they may quite likely be crushed, and movement occur from that cause. The mortar used need not be

rich in cement. Clear sand, if confined so that it cannot run out, makes a perfect bed for a stone, but is objectionable on account of holding water, which may freeze and throw the wall. Very lean mortar, and plenty of it to fill all voids, is far better than rich mortar scantily used.

The report briefly mentions the use of concrete for backing stone masonry. This practice is worthy of encouragement, and also the practice of using concrete for filling between the front and rear faces of walls, the hearting of piers, etc.

Pointing is touched upon only by describing the mortar to be used for the purpose. All exposed joints of masonry should be pointed. The joints should be raked out at least one inch deep before the mortar has set. This is not commonly done, but should be. It costs nothing, and it leaves the joints in good shape to hold the pointing mortar. The ragged edges and points of cement left by raking out the joints while the mortar is green help to furnish a good hold for the pointing mortar when it is applied after the wall is completed. If the joints are left full and they are cut out with a point, as is usually done, the groove is smooth and rounded and generally not very deep, with the result that the pointing gets a very poor hold.

Another fault frequently seen in pointing, especially second and third class work, is the tendency to plaster the face in order to fill out inequalities in the stones, making joints 3 or 4 inches wide in some cases. The mortar in this case is spread out to thin edges, which are bound to quickly separate from the stone, leaving a chance for water to work in, which will eventually follow down to the center of the joint and throw out the whole of the pointing. The better way is to keep the pointing mortar well back in the joint, say  $\frac{1}{4}$  inch from the face of the stone, and not let it spread on the front at all. In this case the stone protects the mortar somewhat from the weather.

It is doubtful if the fine cutting of bridge seats and parapets, hinted at in the report, is worth what it costs. Only the bearings of the iron work need be fine cut, and this can be done better after the stones are set. If it is necessary to set a stone precisely to a given height, the bedding is apt to suffer, and for bridge seat stone thorough bedding is absolutely essential; hence it seems better to bed the stone properly and cut the bearing spot afterward to the exact height and level required.

President Kittredge:—The report of the Committee on Records, Reports and Accounts, on account of delays, has just come from the printer, and as it is quite long, I am sure none of you have seen or read it. Therefore, any discussion of that will be postponed until this afternoon, and in order that we may not lose time we will depart from the regular order of business and take up the item of "New Business."

In regard to "New Business," an amendment to the Constitution has been submitted by letter ballot, and the Secretary will read the amendment and announce the result of the letter ballot.

Secretary Fritch:—The amendment submitted is as follows: "That Article VIII (Meetings) be amended by adding the following: Section 4.—Discussions shall be limited to members and to those invited to speak by the Presiding Officer." For the amendment, 233 votes were cast; against the amendment, 4 votes.

President Kittredge:—Another matter that comes up under the head of "New Business," is something that the Board of Direction especially desire to have discussed by the members of the Association. That is the matter of the work and the reports of the committees. This meeting has demonstrated both the necessity of having prompt reports—reports that are the results of the united efforts of the committees, and reports that are submitted promptly and on time, so that they can be spread abroad and dissected and discussed and thought over by the members before they come to the meeting. Your Board of Direction have worked hard to get reports in in that shape, with what measure of success the Association knows. It would be time well spent for us to discuss that question openly in the Association, so that all the members, and especially those present who are members of committees, may know the attitude of the Association. The Association has a right to expect good work from its committees, and should insist upon it.

Mr. J. A. Atwood (Pittsburg & Lake Erie):—I would like to present an argument concerning the formation of committees which was called to my attention by Mr. Handy, Chief Engineer of the Lake Shore & Michigan Southern. He thought better results might be obtained if the committees themselves were made up of local men, who could reach each other and get together in order that they might consult on the different questions that came

before them. The committees are now made up in such a way as to get representation on the committee from all parts of the country, and it is difficult for them to get together and have proper consultation. If the committees were local and the questions under discussion were brought before them by correspondence, it might possibly result in greater benefit and in better discussion.

Mr. W. M. Camp (Railway and Engineering Review) :— I understand that question has been before the Board of Direction. I think it would be interesting if some member of that Board would state the results of their deliberations.

President Kittredge :—I might say for the Board that there are a good many questions and phases of the questions that have presented themselves and have been discussed. It seemed essential in the early days of the Association to attract interest from all parts of the country. In order that that interest might be attracted, committees were selected from various sections of the country widely different. As time goes on and as we become more familiar with each other, and particularly since we have become founded on what seems to me a permanent basis, we can use our discretion in selecting committees in a manner different from that which we followed in the first place. We do not condemn the method that we used in the first place in selecting our committees. It has served a good purpose. It has interested people in all the different sections of the country. That interest having been once aroused, we are satisfied that it has been so thoroughly aroused that it will be retained. It is in a general way the idea of the Board that in selecting committees in the future a chairman shall be selected from one section of the country and a vice-chairman from another section; that this chairman and vice-chairman, respectively, shall corral the members in their neighborhood, those members being selected preferably from locations which are not further removed from the chairman or vice-chairman than one day's ride or one night's ride. Then, as these two branches of the committee hold their meetings, usually, monthly, the actions of the one can be transmitted before the next month to the other, and in that way accomplish results that we have been unable to accomplish fully in any other way. That plan was followed in the Committee on Yards and Terminals. We were most fortunate in the original chairman of that

committee, in selecting a man who was very methodical and who enjoyed that kind of work, and he aided the Board, with the result that the report of the Committee on Yards and Terminals could be considered more nearly a model than any of the others, many of which have been excellent. This discussion was primarily to hear from the members, and not from the Board.

Mr. C. Lewis (Baltimore & Ohio):—It is with a good deal of hesitancy that I would rise to discuss a question which I am sure has received the earnest consideration of so able a Board of Direction as our own, but there are times when, as in gardening, if one starts to prune and train a wild tree or a tree which is not giving satisfactory results, it may take a great many years to accomplish the result desired; whereas, it may be a good deal quicker to cut it down and engraft an entirely new idea. The suggestion which I would like to offer for discussion is almost a complete change of present methods. If the committees were to meet every month and work efficiently and turn their reports in in ample time to be printed and sent out for discussion, we would still have the meeting called once a year, at which members would be expected to discuss a large number of formal reports, and the meeting then, as now, would be considerably cut and dried beforehand, with recommendations laid out, of which there would not be much doubt of acceptance, if the committees were at all conservative, and there would not be the interest in the work which there should be. There would not be the flexibility to take up new problems and meet them at once as they arose, as I think there should be in an association of this kind. The suggestion which I would like to offer is that the committees as at present constituted keep up their work without any change, excepting perhaps that the date of their report, if necessary, be altered, or, if necessary, the date of their report be abolished. There are some committees which have nothing to report for five years, and there are other committees we would like to hear from every month; to which we would like to turn over special problems and have them report to us and give us the result of their investigations promptly. We cannot do that with an annual meeting, and it seems to be out of the question to hold more than one meeting a year of all the members. To make this committee work more effective, as well as for other reasons, I would like

to suggest that we have a monthly publication; that monthly publication to consist of two parts, one a part containing such reports from committees as may have been submitted to the Secretary before the date of the publication, presuming that he will have several on hand and publish them in their turn, and written discussions on such reports as have been submitted; the second part of the publication to consist of the working up of future reports. That is, the bulletins for information which are issued by the committees, the replies to those bulletins; correspondence between the committees and the members, and between the members themselves; requests for information on maintenance-of-way topics; in other words, transient information of little permanent value, which would not be reproduced in any volume of transactions, but merely an interchange of ideas, and showing what progress is being made in the work. The way the work is handled at the present time, I think many of the members get seven or eight circulars for information each year, which, if carefully replied to, would constitute a volume on railroading which would be complete in itself. Most of them promptly throw those circulars in the waste-paper basket because they have not time to answer them all. There is another class of members who carefully pigeon-hole them in the hope they may be able to answer them later, and they never get that far. Whereas, if you were the next month to read a reply from some member who had taken the trouble to answer his circular, that might lead you, in a spirit of combativeness, to send in your answer. At present you see no answers until the committee brings in its report, and then our time is taken up by trivial discussions and criticisms of minor points which could have easily been handled by correspondence. I think I do not exaggerate by saying that fully half of the time we have devoted to discussion during the last three days has been taken up with suggestions and comments which could have easily been made by correspondence to the committee, and which the committee would willingly have accepted and incorporated in their report, if any of the members had taken the trouble to do so. There is no reason why the Association should devote its time to such discussions. Under the system here advocated, all of this discussion could be held by mail. In the monthly publication, each committee would have at its disposal a certain amount of space,

if it cared to use it, for its correspondence and inquiries. A member interested in masonry could keep in touch with masonry each month, and a member interested in buildings, etc., could see what was going on every month; and when the meeting was called it would be exclusively for the consideration of such results as might be offered to the Association for final action and adoption. If the committees had nothing to report for final acceptance, no time would be wasted. All their progress reports could be handled by mail and through the publications, and we would not have to consider at the meeting anything but subjects presented to us for official adoption. The remaining time of the meeting could then be given up to the discussion informally of special topics, and I think the Association could then better keep in touch with the work as it progresses from day to day. Special topics could be placed before the committees for their immediate consideration, and they could keep more closely in touch with the needs of the members on the special subjects to which they were assigned. I would therefore move a resolution that the Board of Direction take into consideration the matter of establishing a monthly periodical or volume of proceedings, such as has been outlined, and if they consider the idea favorably, that they be authorized to put it into execution.

(The motion was seconded by Mr. Atwood.)

Mr. Edwin F. Wendt (Pittsburg & Lake Erie):—I think the Board of Direction should take one step farther. I have in mind a certain committee appointed in March, 1901, which did no work until the 1st of February, 1902. Now when the Board of Direction finds that the members of a certain committee have done no work within the first six months of the year, they should take the matter in hand and ascertain why the committee is doing no work, and if they have not accomplished satisfactory results, the committee should be summarily discharged. In this way only will the work be expedited. The work of the committees is largely in the hands, as far as progress is concerned, of the chairman. He is supposed to lead and the individual members do not feel justified in attempting to take the lead. I would suggest that the Board of Direction take this matter under consideration and, where such conditions are found, that some other action be taken. Where members on a committee do no work for a year, without sufficient excuse, it seems to me they should resign. I have in mind

a committee made up of men, one from Montreal, one from Florida, two from St. Louis, from Detroit, Zanesville, Pittsburg, Cleveland, Buffalo. It is quite apparent that a man can hardly travel from Florida or Detroit to Chicago for a meeting unless he is very much interested; and under the revised system of transportation in existence this year, whether he gets a pass or not is a vital question. One of the members of the Association has suggested that when a member asks for a pass to attend a committee meeting he request the transportation on the ground that he is a member of the Association, and not on the ground that he is an employé of a railroad. Probably this would enable the members to obtain free transportation to a central point where a meeting would be held. I make the suggestion in view of the difficulties attending the work of the committees.

Mr. H. G. Prout (*Railroad Gazette*):—I came in at the conclusion of Mr. Wendt's remarks, so I do not know precisely what his suggestion or resolution was, but two or three things occurred to me with relation to this work that it might perhaps be well to speak of. It has always struck me that the original layout of the work of this Association is very admirable as we look at the program. We can see what the fathers of the constitution had in mind, viz., to lay out a great general scheme which it would take a long time to carry out. If the work of those committees were all done in one year we would produce an encyclopedia of railroading, so far as engineering and maintenance-of-way goes, but of course nobody ever had any notion that that would be done. The development of this scheme should go on, and either small, compact committees take up independent subjects or small, compact sub-committees take up special subjects. I do not see that it makes the slightest difference whether that is done by independent committees or sub-committees working under the direction of the chairmen. The important matter is that the men who go into this thing should go in with a resolution to work. Last year, after the convention, I received a circular, which I presume every member of the Association received, asking what committee I would like to serve on. I am ashamed to say I never replied to that circular, but it was not carelessness. Still, it was due to the Secretary and the officers that I should have replied in some way. But I thought about it seriously for some time and I did not feel that I

could take upon myself the burden of doing any committee work, and therefore, having a vestige of conscience left, I decided I would not go on any committee. It seems to me no man ought to take a position on any one of the committees unless he is prepared to do the work.

The Board of Direction can do pretty much as it pleases. I assume most of the members of the Board want to find out how the members feel about getting the work done. I do not see any necessity for passing a resolution instructing the Board. A suggestion was made last night that it would be an excellent plan to publish the reports monthly, then, the following month, publish the written discussion that has come in. There are certainly very fine points in that plan. Speaking as a journalist, I should approve of that very much. There is nothing in my work that I regret more than the apparent necessity for getting out great big special numbers of the paper once in a while. I accumulate a mass of splendid material and concentrate that in this one issue of the paper and people look at it and say, "Oh, that is fine, that is splendid. I will read it." They take it home and lay it on one side and they never read it. They can not do it. We are all too busy. I have three or four cords of pamphlets and magazines in my library that I am going to read some time, but I never shall read them. If your reports were published each month, I can easily see how the members could take up those reports and consider them carefully and produce some results, and this work could be carried right along throughout the year.

Mr. J. F. Wallace (Illinois Central) :—I have listened to this discussion with a great deal of interest, and as Colonel Prout says, it was not the intention, when these committees were formed, to have them thoroughly and exhaustively complete their work in one month or in one year. The idea was to form a skeleton of our work and outline it generally, so that every paper or report made and every word spoken should fall into a fitting place, and in the end that we should work towards the solving of our problems as a whole. I think the suggestion as to the publication of the reports monthly is good, with this modification, that it should be confined to a single report each month. Once a year or once in 18 months is about as often as you can have a general round-up of the work of any of your committees, and if you try

to get something from each committee each month, I do not think that we will accomplish as good results as we would if we arranged to have committee reports one each month printed in the bulletin, and the discussions follow, and at the annual convention call up these different reports and have the discussion center around them. There is no body of men connected with our Association that can act as a general committee in this way better than the members of our Board, serving from year to year and changing slowly and being familiar with the work of the Association.

President Kittredge:—In regard to the remarks of Mr. Wendt, it is possible that if all the internal workings of the Board were thoroughly known, the reason why there were changes in chairmanships during the year and why there were delays in getting new men would be better understood. The remarks made by Mr. Wendt only shadow the action of the Board throughout the year. As far as I could learn, there was not a point made by him that had not been fully discussed and acted upon by the Board during the year. If you find one set of committeemen that is not efficient and a new set is established, it takes some little time to find out whether your new set is any good, and by the time you have made two or three such changes the year is gone.

Mr. T. L. Condron:—Some serious criticism has been made of the lack of action of the committees as a whole. There is more trouble to be found in the lack of action of individual members of the committees. Every committee has one or more workers upon it, and one or more men who are so extremely occupied with their business pursuits that they can give no attention to the committee work, but, like the government officers, few die and none resign. So that a man still retains the honor and distinction of being a member of one of these committees, which is an honor and distinction, although he may be doing nothing for the benefit of the Association. I would say, if it should seem to the Board desirable, that there be a penalty provided, so that if members of a committee fail to attend one or two committee meetings, they thereby lose their position.

Mr. W. McNab (Grand Trunk):—I appreciate all Mr. Lewis has said, and I think I voice the opinions of everyone present when I endorse the pertinency of the remarks; but I think

that it would be better, instead of offering a resolution, that it be made in the form of a suggestion to the Board of Direction. There are a great many things to be considered in a radical change of that nature, a discussion of which would protract this meeting too long. I would respectfully suggest, for the consideration of the Board of Direction, the advisability of each committee appointing its own chairman. I can see the value of the Board of Direction appointing individual members, but I think the committees should be allowed to select their own chairmen, and, if necessary, have the appointments confirmed by the Board of Direction. It is unfair, I think, for some of us apparently to usurp the honor. I wish this remark to be considered personal, for I consider the chairmanship of a committee a great honor, and in my mind it would be a greater honor if the office were elective. It means a great deal of work, but it ought to be a labor of love.

President Kittredge:—I think Mr. Lewis' motion was that the attention of the Board of Direction be called to that method of conducting operations in the future; it was not that they should be instructed to do so.

Mr. Lewis:—That they be requested to consider the matter.

President Kittredge:—I wish for the present to turn matters over to First Vice-President McDonald. Mr. McDonald will look after your welfare.

Secretary Fritch:—The following gentlemen have been selected as tellers to canvass the votes cast for officers of the Association for the year 1902: W. B. Poland, chairman; G. M. Walker, Jr., and G. A. Mountain.

Chairman McDonald:—Any further discussion on the motion of Mr. Lewis? It was understood that the motion of Mr. Lewis is simply a suggestion to the Board of Direction, and not an instruction. I will state in behalf of the Board that it will give the matter due consideration.

Mr. McNab:—I would move that it be suggested to the Board of Direction the advisability of the committees that have been appointed by the Board of Direction electing their chairmen. There is no doubt the chairman has a great deal to do, and the members of a committee know who will do the work, and, further, they want some person who will carry it through to a finish,

and I think they should be allowed the choice. I beg to move that the Board of Direction accept as a suggestion the advisability of the committees electing their chairmen.

Chairman McDonald:—On behalf of the Board I will state that this matter has been very thoroughly considered by the Board. As a preliminary step to the election of a chairman, a meeting of the committee is necessary, and it was found almost impossible to get the committees to select their chairmen. The Board, however, will give the matter further consideration, according to the suggestion of Mr. McNab.

(Recess until 2:00 o'clock p. m.)

#### AFTERNOON SESSION.

The meeting was called to order at 2:00 o'clock p. m., First Vice-President McDonald in the chair.

Chairman McDonald:—The Committee on Records, Reports and Accounts will now make its report through the vice-chairman, Mr. Wendt, in the absence of the chairman.

#### REPORT OF COMMITTEE No. XI.—ON RECORDS, REPORTS AND ACCOUNTS.

*To the Members of the American Railway Engineering and Maintenance-of-Way Association:*

The object of all the work of a Railway Engineering and Maintenance-of-Way Department is to promote and insure the safe, economical and expeditious movement of traffic; in short, the aim is to get results.

The usual questions asked by the Railroad President are: How much did we make? What has been accomplished? The answers to these questions are found through Reports, Records and Accounts, and hence this subject is worthy of very careful study.

Inaccurate reports are worthless; incomplete reports are a nuisance; and unnecessary reports, records or accounts involve an extravagant use of the company's funds.

The first question that naturally arises is, How much and what reports, records and accounts are necessary? This Committee has not undertaken to determine positively what number of reports should be recommended. It has been the intention rather at this time to consider a few reports and records which are essential and which are universally used by every railroad.

It is believed that a careful study of this entire question will indicate that many railroads are using more blanks and requiring more reports

and records than are necessary. It will be the aim of this Committee in the future to consider what reports are necessary and what reports now being used by different railroads are considered unnecessary.

It is reported that a certain prominent railroad of this country, after a careful analysis of the different blanks used in the different departments, reduced the number of blanks from 1,500 to 500. This great reduction not only involved a large decrease in the necessary expenses of a railway for clerk hire and for stationery, but it also relieved the different officers from the unnecessary labor of examining and considering a mass of details from which no adequate results were obtained.

In determining the necessity of a report or a record or an account only one principle should be followed, viz.: What good result is obtained?

### RECORDS.

Right-of-way Records, Deed Records and Alignment Records were considered more or less fully by the Committee in 1901, and no further data are given this year. The time of the Committee has been occupied with other work.

Records of Leases were included in the report of 1901, but the subject was left incomplete and it was the intention of the Committee this year to further consider the matter of leases, but this subject has been reserved for the 1903 report.

**BRIDGE RECORDS.**—The subject of bridge records has been considered by the Committee this year and a partial report is made, with the understanding that the Committee does not submit this as a complete report. The subject is of such great importance and is so comprehensive as to require more study, and it is believed that the Committee in the future could not do a better work than to follow up this subject.

Our investigation so far reveals the fact that the railroad Bridge Departments are weak on this very point of records. There does not seem to be any uniformity in the systems in use, and it is apparent that many roads are keeping very incomplete records of their bridges.

Most of the inquiries sent out by the Committee were answered with the statement that no particular system was used. We are convinced that the different engineers of the country have failed in the past to give much consideration to this subject, with the result that the systems now in use are uneconomical.

Results count, and efforts should be made by this Committee to prepare a system which would be universally applicable to the conditions throughout the entire country—a system which would be accurate and complete and which would include no unnecessary data.

The Committee presents to the Association herewith an illustration showing a full-size page for a bridge record book. It is hoped that the members of the Association will carefully consider this suggested record and offer any criticisms which they think proper, based on their experience.

# BRIDGE RECORD. (Size of Pages 13 1/2" x 14")

DIAGRAM.

BRIDGE NUMBER 45.60

NAME—Jackson Swamp.

PLAN 215—23—8.

DIVISION Norfolk.

SUB-DIV. 8

LOCATION—45.6

Description.	Mo.	Yr.	Cost		Inter- est.	Total	Remarks.
			La- bor	Ma- te- ri- al			
Standard Trestle	10	1899					
Elevation of Rail Base						108.68	
Number of Framed Bents on Sills							
" " Piles						6	
" " per Bent						4	
" " Spans						5	
Spans C. to C. of Caps						12	
North Abutment 0						2.3—12.1—11.8—11.8,	
etc., to end S. Abut.							
Total Length						64.9	
Depth Rail to Swamp Bottom							
North Abutment 4.0						4.8 6.8—6.9, etc., to	
end							
Depth Rail to High Water						3.0	
" " Low						5.0	
Unobstructed Waterway						55.0	
Drainage Area							
Kind of Water						Fresh	
Foundation						Good	
Soft Mud 10, Clay 10, Sand 10.							
Penetration last 25 blows, Inches Fall						3,000 lbs.	
20 Hammer							
Material—Bill.							
Piles, Cy press, 8' to 16' diam., 40' long.						24	
Caps, Ga. Pine,						6	
8 x 12 x 12						6	
8 x 15 x 26						9	
Stringers, Ga. Pine,						4	
8 x 15 x 24						4	
8 x 15 x 16						4	
Ties,						56	
8 x 8 x 9						8	
Guard Rail							
8 x 8 x 16						6	
N. Abutments, Creosoted Pine,						6 x 12 x	
6 x 12 x							
" " "							
" " "							
" " "							
Penetration of test piles each 25 blows 1						Inches Fall	
" " "						" "	
" " "						" "	

In order to obtain all the information for a Bridge Record that will be of value for future reference, it is best to begin with the first stroke made toward its erection.

A standard form should be used in gathering information for the several classes of structures, and these should be furnished the Engineer or Bridge Superintendent in charge of the work, and he should be required to fill in with the desired information as the work progresses.

If the structure is already completed and no records are available, a survey will, of course, have to be made.

Using a Pile Trestle as an illustration of the method, the following information should be given:

Plan—Number and File Number.  
Elevation of base of rail above base line.  
Number of Bents.  
Number of Piles to the Bent.  
Number of Spans.  
Spans, Center to Center of Caps.  
Total Length, End to End of Structure.  
Depths at each Bent; Rail to Bottom of Stream.  
Depths, Rail to High Water.  
Depths, Rail to Low Water.  
Unobstructed Water Way.  
Drainage Area.  
Water—State whether fresh or salt, and if exposed to the "teredo."

**FOUNDATION.**—Under this head should be shown the results obtained while driving piles in each bent. We thus obtain an accurate cross-section, showing the direction of the different stratas, which will be of value when planning for a permanent structure.

**MATERIAL.**—Should show:

Kinds of Piles—Size, Length and Number.  
Caps—Dimensions and Number.  
Stringers—Dimensions and Number.  
Ties—Dimensions and Number.  
Guard Rail—Dimensions and Number.

**ABUTMENTS.**—Description, giving dimensions and material used in construction. The record should be entered in a book on the left-hand page, properly ruled for the purpose, at the head of which should be given:

Division name on which structure is located.  
Sub-division or Section Number.  
Distance from Terminal.  
Number of Structure from Terminal.  
Name of Structure.  
Date work was started.  
Date completed.

It is recommended that bridges be numbered by location in miles and hundreds from one terminal running toward another. If additional structures are then added it will not be necessary to use half numbers or letters

of the alphabet. Bridges on branches should be numbered after the same system, using an initial to designate each branch road.

**Costs.**—The page containing the above described record should be wide enough to permit of entering the costs of the structure and its annual cost of repairs, with any remarks that will be of value in determining the life of the material.

This record should show cost of labor and material, separately, both for sub-structure and super-structure; also the annual interest charges on amount invested. With this record properly kept there will be no difficulty in determining the exact amount we would be warranted in spending on a permanent structure.

The remarks column should state, generally, the quantity of material used in annual renewals, and if paints were used, should give quantity, kind and dates, and from whom purchased.

On the right-hand page should be shown a cross-section and sufficient of the side elevation to give a general idea of the structure, above which should be shown the plan and file number for convenience in referring to complete drawings, should it be desired. It would also be well to attach to this page a photograph of end views of all structures.

In order to keep these records properly, the officer in charge of bridges should be held responsible for their maintenance in their recorded forms. The annual repairs should be determined by the joint-inspection of the Engineer Maintenance-of-Way and the Superintendent of Bridges.

The Superintendent of Bridges should send to the Engineer Maintenance-of-Way daily reports of the work done and material used, giving cost of the labor and number of the structure on which work was done, these reports being checked against the records of authorized repairs.

From these daily reports, after checking with time books, should be figured, monthly, the cost of all work, showing material used, pieces and dimensions. This should be entered in a Monthly Cost Book, from which, by combining the various months' work, the annual statements can be made, in a more condensed form, for the permanent record.

With this record, the cost of any work to date could be quickly furnished.

Plans on tracing cloth of super-structure and masonry, with foundation plan of each bridge, should be filed together in atlas form, detachable so prints could be had at any time. Plans of super-structure should be separate from masonry and foundation, and of same size, 20x36.

Scale for general plans  $\frac{1}{4}$  inch equals 1 foot. For detail plans,  $\frac{1}{2}$  inch equals 1 foot. Topography for 300 feet in all directions should be shown in one corner of masonry and foundation plan on a scale of 100 feet to the inch, with a profile extending 300 feet or more each side of the bridge.

Date of erection, name of maker, cost and distance from terminal, in miles and hundredths, to be marked on plans.

When large bridges occur requiring more plans, plans to be made in multiples of length and of same width, 20 inches. Arch culverts, trestles, open culverts, box culverts should be treated in the same manner, according to their requirements.

DRAWING No.

(Use cross-section paper.) 8 1/4" x 14"

PHYSICAL CONDITION:

REMARKS:

STATION.	CLEAR HEAD.	The American Railway Engineering & Maintenance-of-Way Association.
CROSSING.	CLEAR WIDTH	RAILROAD BRIDGE.
MILE.	BUILT.	ORIGINAL No. NEW No.
ALIGNMENT.	LIVE LOAD.	
ANGLE.	MATERIAL.	

**Book records of bridges should be kept.**

All plans should be filed according to the card index system. (See sample of card below. Card should be 4"x6" in size.)

[illegible]

It is a good plan to make sketches of every structure on the line, and to make these sketches on a page of the Record Book, previously described, the object being to enable anyone to tell in very short order just the character of the structure or crossing without hunting through a mass of drawings.

Once each year an examination of all structures should be made by the Bridge Engineer and the Engineer Maintenance-of-Way, and a decision made as to what work should be done in the way of strengthening and maintenance.

### SYSTEM FOR FILING RECORDS, REPORTS AND ACCOUNTS.

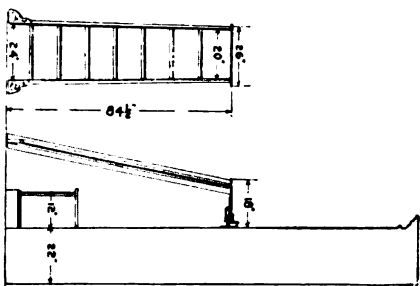
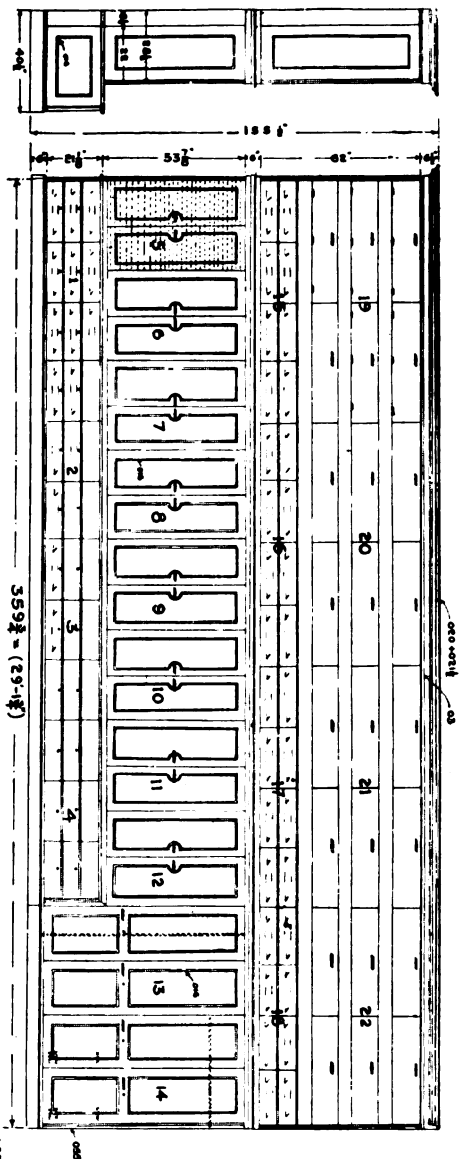
**First**—A place in which records may be filed.

Second—The ready locating of them after they are filed.

The form of the index cards varies with the practice in different offices; but some index that will permit the instant location of any desired plan







A. M. RY. ENG. & M. W. ASSOCIATION  
 COMMITTEE ON RECORDS, REPORTS AND ACCOUNTS  
 CHICAGO MEETING 1908.  
**PLAN OF FILING CASE, N. Y. C. & H. R. R. R.**

or paper is a first requisite to their proper filing. Cards for this purpose may have any number of cross references, indicating the disposition of any drawing sent out, changed, etc.

The adequate storage for engineer's records involves ample room, light, freedom from dust, security and proper cases, arranged to permit of any classification outlined by the card index. Where records are kept in buildings not fireproof, they should, of course, be stored, if valuable, in vaults. Where buildings are fireproof, and the amount of plans and papers is large, it is better to store them outside of vaults, securing more light and room, and equipping the room so that it will be a vault in itself. The New York Central Railroad has a room of this character in the new Grand Central Station, all the woodwork being eliminated, the floors concrete, doors fireproof to shut out fire from other parts of the building, and the room equipped entirely in non-combustible fittings.

Exposed facades should also have protection at windows. Whether stored in vaults or rooms, the case work should be of material occupying as little space as possible, durable and non-combustible. Cases for the several classes of engineer's records and plans would of necessity be suited to the special requirements for each office, but some points may be mentioned connected with each form of record.

Rolled plans are most conveniently and securely filed in map tubes or drawers, one drawer given to each rolled plan or set of plans in one roll. This method, however, while entirely free from dust, is expensive from the point of cost where there are large masses of plans to be filed.

Large drawers properly sub-divided by partitions may be conveniently utilized for this class of papers, or they may be stored directly on open shelving, the shelving spaced to suit the diameter of the rolls. Where very large masses of old plans are to be accommodated, compartments or bins with drop fronts may be provided. This method is utilized in the room of the New York Central, mentioned above. Plans for current use in fireproof rooms can be conveniently disposed of in bases covered with table tops or drawing boards.

Plat plans or tracings are best handled in shallow drawers, the rear of drawer being fitted with a hood to protect the rear edges of plans. A good file or drawer for this purpose is one having a drop front, which when pulled down, reveals the entire contents of the drawer at front.

**PLATS.**—Plats mounted on card board or in thin books can be kept on shelves, spaced in height the thickness of the book, having a vertical index at the right or left of opening on a narrow strip. The whole case to be protected by curtains or doors. These shelves need not take up over  $\frac{3}{4}$  inch vertically. The front of shelf should be stepped back 2 inches under the book or plat, so it may be handled readily.

**LEASES.**—These are more conveniently kept in document files than in any other form of device.

For the construction of case work for this purpose metal has some distinctive advantages, requiring less space and being non-inflammable. The large amount of engineers' records lost by fire gives especial im-

portance to the last point. The New York Central room is equipped in metal work of this kind, as are the filing rooms of the Pittsburg & Lake Erie Railroad in the new Central office at Pittsburg. The "Engineering News" of January 2, 1902, illustrates the equipment of the last-named room very clearly.

Illustrations showing the filing case in a model vault are shown below:

#### CARD INDEX SYSTEM.

The following explanation of the card index system has been taken from an article by Mr. R. P. Forsberg in the "Engineering News" of January 2, 1902. The explanation and illustrations are exceptionally clear and complete:

All drawings pertaining in any way to the main line or branches of the road are indexed by location, as hereinafter explained. The name of the nearest station or depot at which the structure or map is located always appears in the title of the drawing. For example, our standard title for drawings is as follows:

P. & L. E. R. R.  
6' 0" CONCRETE ARCH CULVERT.  
at Sta. 3365 near  
Haselton.

Scale  $\frac{1}{8}" = 1' 0"$ .

June 23d, 1901.

In the lower left-hand corner of the drawing appears the file number, 3067RS17.

In our card index system we have divided the main line and branches into sections, including from one to six stations or depots, dependent upon

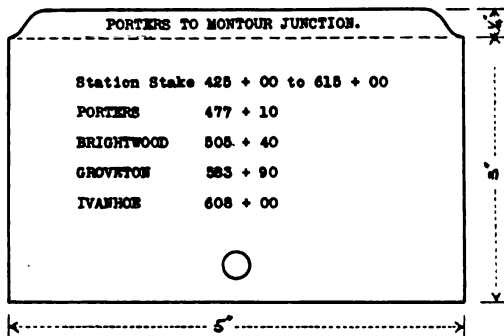


Fig. 4. Sample of Salmon Guide Card, Showing Section of Road Crossed.

the number of drawings included in that section. These sections in the card index drawers are defined by salmon-colored guide cards, which extend the entire width of the drawer, projecting  $\frac{1}{4}$  inch above the index cards. On the  $\frac{1}{4}$ -inch projection is printed the stations or depots at the extreme limits of the section, and on the body of the card the engineering station stake pluses of the limits of the section and the names of the

stations or depots included in this section, with their station stake pluses, as shown in Fig. 4.

The next salmon card, of course, reads "MONTOUR JUNCTION TO STOOPS FERRY," etc.

**TRACK PLANS.**

- All track plans.
- Yards.
- Proposed Yards.
- Preliminary Surveys.
- Locations and Proposed Locations.
- Tipple Tracks.

**RIGHT OF WAY.**

- All plans showing land conveyed.
- All plans of proposed conveyances.
- Special Record Plans showing Right of Way.

**BUILDINGS.**

- All buildings, Sheds, Mail Cranes, etc. etc.
- Coal and other Tipples supporting Mine Cars.
- Coal Chutes not carrying Railroad Tracks.
- Water Tanks, Pump Houses & Stand Pipes.
- Plans and Profiles of Water Supply.
- Wagon and Platform Scales (Except Masonry).
- Platforms (Wooden).

Fig. 5. Samples of Blue Guide Cards, Showing Classification of Drawings and Records.

Between these salmon cards are twelve subdivisions, defined by blue cards, known in stock as "thirds." These also have a  $\frac{1}{4}$ -inch projection above the index cards, the projection extending one-third the width of the drawer. On this projection is printed the name of the subdivision, and on the body of the card the class of drawings that are indexed under this subdivision; for example, three of these cards are shown in Fig. 5.

This description of the drawings, indexed in each subdivision, is intended both as a guide to the person indexing the drawings and an aid to a person not familiar with the system in locating a drawing. The twelve subdivisions are as follows: "Track Plans," "Right-of-Way," "Buildings," "Agreements," "Masonry," "Property Plats," "Bridges," "Profiles," "Cross Sections," "Grade Crossings," "Miscellaneous" and "Obsolete."

Between the blue subdivision cards come the buff index cards, which are ruled as shown in Fig. 6.

NEAREST STATION.....	FILE NUMBER.....
STATION STAKE..... TO.....	PAPER.....
DESCRIPTION.....	TRACING.....
.....	PRINT.....
.....	DATE.....
.....	
.....	
.....	
.....	

Fig. 6. Sample of Index Cards.

It can be readily seen that with this system one can at once turn to the desired subdivision at any station or depot and only read the index cards of drawings located in the vicinity of that station, usually not over four or five in number.

In the event of some special piece of work which requires a large number of drawings, and consequently would necessitate looking over a large number of index cards in finding a drawing, a set of alphabetical tab-cards are inserted in this subdivision and the index cards are arranged behind them alphabetically. For example, the drawings for our Pittsburg Terminal Station come under the general division "PITTSBURG TO SAW MILL RUN," subdivision "BUILDINGS," therefore in this one subdivision the cards are arranged alphabetically behind alphabetical tab-cards.

The "Miscellaneous" subdivision pertains to drawings having a definite location on the road, which, however, could not be placed under any of the above subdivisions. The "Obsolete" subdivision pertains to drawings which have become obsolete and yet have in themselves sufficient value to warrant their preservation. These obsolete drawings, after being properly indexed, are stored in the basement of our station in strong wooden boxes, and in the event of their being needed are easily accessible.

Standard drawings, which of course have no definite location on the road, and miscellaneous drawings having no location, are indexed alphabetically behind alphabetical tab-cards in special drawers, marked "Standards" and "Miscellaneous," respectively. All catalogues pertaining in any

In order that the space in the filing case which is made vacant by a drawing being destroyed or relegated to the obsolete case in the basement may be again filled, we have a book which we designate "Ledger," divided into sections corresponding to the compartments in the filing case. In this "Ledger" in the proper section is kept a record of the drawings with their file number. Space is left under each entry for two changes of title, should a drawing occupying the same space and having the same file number become twice obsolete. In another book, which we designate "Journal," each drawing is entered or recorded as soon as completed, without regard to its compartment in the filing case, taking its journal number next to the last one entered.

This same card index system, with the same divisions of main line and branches, is used in keeping our siding record. The siding record in-

NEAREST STATION, NAME OF TRACK.				
Length, Total Feet				
" Clear "				
Ownership by R. R. Co., feet				
" Others "				
Name of other Owner				
Point of Switch, Sta. Marks				
"                      "				
Date of Const's or of Change				
Plan File				
Correspondence File				
Agreement—Kind—File				

Fig. 7. Sample of Siding Record Index Card.

dex cards are ruled as shown in Fig. 7. This ruling enables us to make three changes in the length, ownership, etc., etc., of the siding before a new card is required. The same system, with the same divisions of main line and branches, is used for indexing our record books containing survey notes, cross-section notes, etc., etc.

### STANDARD SIZE DRAWINGS.

All drawings, except continuous maps, profiles, rail charts, cross sections, etc., etc., are made on standard sizes, which are as follows:

Border.	Outside.	Border.	Outside.
8x13 ins.	10x15 ins.	10 1/2 x22 ins.	12 1/2 x24 ins.
8x18 "	10x20 "	10 x28 "	12 x30 "
8x24 "	10x26 "	10 x33 "	12 x35 "
8x30 "	10x32 "	15 1/4 x24 "	17 1/2 x26 "
8x34 "	10x36 "	15 1/2 x30 "	17 1/2 x32 "
10x15 1/4 "	12x17 1/4 "	15 1/2 x34 "	17 1/2 x36 "

Tracings from continuous maps and profiles are made on sheets of varying widths, 70 inches long, from which continuous rolls of blue prints

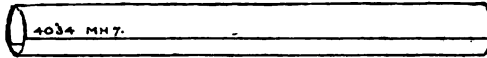
are made. Two sets of tracings, 17 inches by 70 inches, are made from our continuous record maps of main line and branches. One set contains all topography to date, including exterior or governing right-of-way lines only, where there have been several purchases. The other contains only information pertaining to company property or right of way, showing each individual purchase, with number and abstract from deed.

#### FILING CASES.

All drawings are filed in a fireproof vault, equipped with japanned steel filing cases, as shown in Fig. 9. All standard size drawings, including the right-of-way tracings and tracings from continuous or roll maps, are laid flat in drawers, and only the continuous or roll maps are put on the shelves.

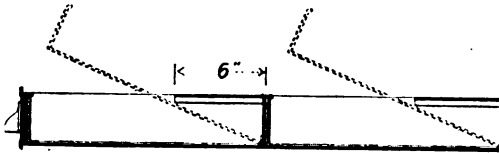
These have their file number on the outside at either end, as shown.

The location of the compartments in shelves and the drawers is determined by the intersection of the horizontal and vertical letters on the filing cases. The drawings in the compartments or drawers each have a sep-

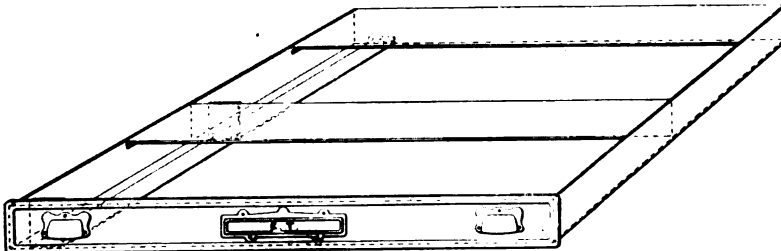


arate file number and are, of course, arranged numerically. For example, in the file number "3067RS17" 3067 represents the "Journal" number, which it is unnecessary to use in locating a drawing, RS the compartment in which the drawing is located, determined by the intersection of these two letters, and 17 its numerical position in the compartment or drawer.

The drawers in the filing case are designed to fit our standard size drawings, and are  $2\frac{3}{4}$  inches deep in the clear. Each drawer has a metal covering at the back 6 inches wide, extending the entire width of the drawer, which prevents the tracings from curling up at the end and becoming mutilated.



Vertical Section.



Perspective View.

Fig. 8. Drawer Used For Filing Drawings.

In the bottom of each drawer, in the left-hand corner, is a metal strip which lays flat and works on a hinge that is attached to the back of the drawer. This is used to raise the tracings and insert the hand when looking for the file number, thereby saving to a great extent the wear on the tracings that would otherwise occur. The method of construction of one of these drawers having two divisions is shown in Fig. 8.

With the exception of the right-of-way tracings, 100 tracings are put in each drawer or each division in the drawer. Dependent upon the size of the tracings, some drawers have two and some five divisions, which hold 100 tracings each.

At the end of one of the steel filing cases, built in the case, are 15 individual safety deposit boxes with lock and key for the private use of the engineers and draftsmen.

The ladders which are used to reach the top shelves in the vault run



*Fig. 9. Metal Filing Cases In Fireproof Vault.*

on an overhead track and can be set up flush with the sides of the filing case when not in use.

The vault is provided with the same system of ventilation that is in use in the other rooms, with the exception of the duct for exhaust air being omitted. As a result of this, the fresh air that comes in the vault is drawn through the vault door opening into the blue print room and out through the exhaust duct in the blue print room. This maintains a steady flow of air outward from the vault and tends to prevent any dust which might be originated in the blue print room from entering.

#### CORRESPONDENCE FILING SYSTEM.

The Committee submits to the Association the following system for filing correspondence. This system is short, yet very complete and well adapted to the needs of the office of the Engineer Maintenance-of-Way. It is based on the requirements of the classifications of expenses recommended by the Interstate Commerce Commission. In practice this system will probably be found satisfactory.

#### CORRESPONDENCE FILING SYSTEM—SUBJECT TITLES AND ANALYSIS.

1. Engineering and Superintendence:

- Engineer corps.
- Architects.
- Supervisors.
- Organization.
- General inspection.
- Engineering outfits—instruments.

2. Roadway:

- Grades—records.
- Grades—changes.
- Grading—on right-of-way.
- Cuts—widening.
- Ditches and drains (except under bridges and culverts).
- Embankments—repairing or protecting.
- Retaining walls (except at bridges).
- Ripraping.

3. Ballast:

- Ballast reports and statistics.
- Gravel banks and shipments.
- Slag, orders and shipments.
- Ashes, orders and shipments.

4. Rail Fastenings:

- Standards.
- Special patterns—tests and reports.
- Orders and requisitions.
- Angle bars.
- Track bolts.
- Nutlocks.
- Railroad spikes.
- Rail braces.
- Tie-plates.
- Tie-plugs.

5. Rails:
  - Rail standards.
  - Rail Tests.
  - Rail—broken or defective.
  - Rail guarantees.
  - Rail shipments—invoices.
  - Rail shipments, other divisions, individual and companies.
  - Rail shipments for frogs, switches, turntables.
6. Frogs and Switches:
  - Standards.
  - Special patterns—tests and reports.
  - Frogs.
  - Switches.
  - Guard-rails.
  - Foot-guards.
  - Switch-stands.
  - Orders, shipments.
  - Condition reports.
  - Switch locks.
7. Ties—Cross and Switch:
  - Cross-ties.
  - Switch-ties.
  - Standard specifications.
  - Old ties—loading and disposition.
  - Lumber (except otherwise specified).
8. Sundry Materials:
  - Material at storehouse (not otherwise specified).
  - Pipe—terra cotta.
  - Pipe—iron (except culvert pipe).
  - Shipping instructions.
9. Tools and Machinery:
  - Standards.
  - Track tools—ordinary.
  - Track tools—special—tests and reports.
  - Hand and truck cars.
  - Portable hoisting engines.
  - Portable pumps.
  - Gas engines.
  - Portable pile-drivers.
10. Tracks:
  - Main tracks and sidings—new.
  - Main tracks and sidings—alignment notes.
  - Main tracks and sidings—changes—alignment.
  - Main tracks and sidings—condition reports.
  - Sidings—company—locate by stations.
  - Sidings—private—locate by stations and name of industry.
  - Team tracks.
  - Sidings ownership—maintenance.
  - Joint tracks and maintenance—agreements.
  - Branch roads—leases, etc.
  - Siding agreements.
  - Gauge.
  - Clearance.
  - Safety Switches.

**11. Bridges and Culverts:**

Bridges—masonry and superstruction.  
Trestles—foundations and superstruction.  
Culverts—including pipes.  
Specifications.  
Inspection and reports.  
Standard clearances.  
All track clearances—overhead and sides—wires, etc.  
Water courses—changes and damages—claim in connection with bridges (otherwise claims damages \$30).  
Masonry materials.

**12. Signals and Interlockings:**

Interlockings—installation and maintenance.  
Interlockings—specifications.  
Signals—distant.  
Crossing bells.  
Electric signals—fouling point.  
Lamps, oil and supplies—oil barrels.

**13. Fences, Road Crossings and Signs:**

Fences and hedges.  
Road crossings—grade—over or under grade.  
Cattle guards.  
Crossing plank.  
Private roads on company property.  
Street improvements (except at stations).  
Railroad crossings—lists.  
Railroad crossings—agreements.  
Railroad crossings—maintenance.  
Railroad crossings—notes.  
Signs—crossing signs.  
Signs—whistle posts.  
Signs—mile posts.  
Signs—clearance posts.  
Signs—elevation and curve posts.  
Signs—property line and survey station posts.  
Signs—trespass signs and warnings.  
Signs—section posts.  
Signs—yard limits signs.  
Signs—sidings.

**14. Stations—Buildings and Fixtures:**

Stations—passenger and freight—maintenance.  
Stations—furniture and fixtures (equipment).  
Transfer platforms and sheds.  
Flag station platforms.  
Station grounds—lawns—flowers, etc.  
Paving and curbing at stations.  
Sewers and drains at stations.  
Mail cranes.  
Scales—track and station.  
Stock yards.  
Cranes—freight, stations and yards.  
Bumping posts.  
Elevators.  
Ice houses.

15. General Office Buildings and Terminal:
  - Construction—plans and specifications.
  - Maintenance—furniture and equipment.
  - Power plant.
  - Office expenses.
16. Houses—Dwelling, Power, Signal, Watch and Tool Houses:
  - Construction—plans and specifications.
  - Maintenance and equipment (except otherwise specified).
  - Dwelling houses for foremen (not real estate, outside property).
  - Power house.
  - Signal towers.
  - Watch boxes.
  - Tool houses.
  - Carpenter shops.
17. Engine Houses and Shops:
  - Construction—plans and specifications.
  - Maintenance.
  - Engine houses or roundhouses.
  - Shop buildings.
  - Compressor plants.
  - Sand houses and equipment (except tools and machinery).
  - Buildings for car repairers, etc.
  - Turntables.
  - Heating and lighting any of the above.
  - Ash pits.
  - Engine house pits.
  - Drop pits.
18. Fuel and Water Stations:
  - Construction and maintenance—plans and specifications.
  - Fuel stations—coal tipples—equipment—hoists and inclines.
  - Water stations—tanks and buildings—equipment.
  - Water supply—source—analysis—contracts.
  - Handling coal.
19. Telegraph and Telephone Lines (Construction and Maintenance):
  - Contracts and agreements.
  - Telegraph poles—changing location.
  - Raising wires.
  - Construction and maintenance.
20. Stationery and Printing:
  - Blanks—standard.
  - Blanks—changes, etc.
  - Correspondence—filing system.
  - Standard size drawings.
21. Insurance and Fire Protection:
  - Fire equipment—maintenance.
  - Fire brigades—organization, etc.
  - Insurance—list of property insured.
22. Locomotives:
  - Locomotives—construction and maintenance.
  - Locomotives—work-train assignment.
  - Reports, condition—fires, etc.
  - Loss of locomotive fixtures, etc.

23. Locomotives—Fuel:
  - Coal supply.
  - Coal premium.
  - Storing company coal.
  - Confiscation of coal.
24. Locomotives—Miscellaneous Stores and Supplies:
  - Fixtures, furniture and miscellaneous equipment.
  - Oil, tallow, wash, etc.
  - Sand supply—drying and handling.
25. Passenger Cars—Equipment:
  - Standard equipment—classification.
  - Repairs.
  - Inspecting and lubricating.
  - Heating, lighting and cleaning.
26. Freight Cars—Equipment:
  - Cabooses.
  - Freight equipment—all classes.
  - Standards—construction and maintenance.
  - Car materials.
  - Car scrap.
  - Special equipment freight.
  - Refrigerator cars, etc.
  - Interchange—inspecting, etc.
  - Inspecting, lubricating and icing.
  - Misuse—diverting.
  - Misuse—overloading.
  - Misuse—tracing.
  - Misuse—delays.
27. Work Cars, etc.:
  - Standards.
  - Construction, repairs and maintenance.
  - Flats in work-train service.
  - Ballast cars.
  - Steam shovels.
  - Steam unloader.
  - Pile-drivers—mounted on cars.
  - Snow plows.
  - Work trains—operation reports.
  - Work trains—laying up, etc.
28. Electrical Plants and Equipment.
29. Enginemen and Firemen:
  - Employment—qualifications.
  - Rules governing promotion.
  - Rules governing examinations.
30. Roundhousemen.
31. Conductors, Baggage-men, Brakemen, Yard and Work-train Crews:
  - Employment qualifications.
  - Rules governing promotion.
  - Rules governing examination.

32. Other Train Supplies and Expenses:
  - Uniforms—badges—caps—laundry work.
  - Torpedoes—flags.
  - Ice for company use.
  - Trackage—detoured trains.
  - Transfer expenses—passengers—baggage and hotel bills account washouts and wrecks.
33. Switch Tenders and Signalmen:
  - Employment qualifications.
  - Switch tenders.
  - Targetmen.
34. Watchmen:
  - Crossing flagmen or gatemen.
  - Police department—organization.
  - Patrolmen, etc., services.
  - Prosecutions—trespassers, etc.
35. Telegraph Expenses—(Operation):
  - Operators—employment, qualifications.
  - Operators—rules and instructions governing.
  - Operators—wages.
  - Battery material and supplies.
  - Special service.
  - Contracts for exchange, etc., service.
36. Station Agents and Clerks:
  - Employment and promotion.
  - Bonds.
37. Station Labor:
  - Baggagemen.
  - Mail carriers.
  - Porters and attendants.
  - Warehousemen.
  - Freight handling—systems.
  - Wages and employment.
38. Stations—Other Supplies and Expenses:
  - Sundry supplies.
  - Car seats and presses.
  - Freight and baggage trucks.
  - Laundry—water rents.
  - Heating and lighting.
  - Cleaning and incidental expenses.
  - Car locks and keys.
39. Switching and Track Service:
  - Switching arrangements, joint, etc.
  - Switching rates and orders.
  - Complaints—unsatisfactory service.
40. Loss and Damage:
  - Claims—freight damage.
  - Claims—fire damage.
  - Claims—stock—loss and delays.
  - Articles left or found—trains or stations.

Accident damages—trains.  
Accident damages on crossings, trains, etc.  
Damage to property by water, etc.  
Loss or damage to equipment.

41. Personal Injury:
  - Personal accidents—reports.
  - Company surgeons.
  - Claims and settlements for injury.
  - Witness expenses.
42. Train Accidents—Wrecks:
  - All train accidents.
43. Stock Accidents.
44. Rents of Yards, Tracks and Terminals:
  - Agreements—joint use of yards and tracks.
  - Expenses of same.
45. Rents, Buildings and Other Property:
  - Station buildings—rents.
  - Leases and correspondence pertaining thereto.
  - Licenses and permits—pipe lines, wires, guy wires and leases except real estate matters.
46. Yard and Street Lighting:
  - Lighting system for yards.
  - Lamps at streets—not at stations.
47. Employés—Applications, etc.:
  - Applications for employment (reference).
  - Force—increase—decrease.
  - Force—statements.
  - Wages and salaries.
  - Overtime limits and reports.
  - Holiday notices.
48. Staff—Record and Discipline:
  - Record of employés—employment, etc.
  - Discipline.
  - Examinations—physical.
  - Examinations—sight.
  - Examinations—color.
  - Examinations—rules.
  - Garnishments and bills against.
  - Discharges.
49. Organizations:
  - Staff organization and meetings.
  - Engineers, etc., societies.
  - Labor organizations—agreements, etc.
  - Grievances and strikes.
50. Bills and Accounts:
  - Pay rolls—preparation, etc.
  - Brass checks.
  - Bills against individuals and companies.
  - Reports—monthly material reports.
  - Reports—time distribution.
  - Material price lists.

51. Train and Yard Service:  
Rules—general orders and notices.  
Bulletin points for same.  
Schedules—issuing—changing, etc.  
Manner and schemes—handling trains.  
Delays at crossings, etc.  
Detouring trains—except as provided in No. 32.  
Exceeding speed limit.  
Running crossings.  
Watch examiners and examinations.
52. Reports and Statements:  
Annual reports—operation.  
Progress reports—(combined works).  
Mileage reports.  
Interstate Commerce reports.  
State reports.  
Structure program.  
Authorized new works.  
Monthly reports not otherwise classified.
53. Transportation—Passes, etc.:  
Annual and trip passes.  
Sixty-ride tickets.  
List of passes, etc.  
Telegraph passes.  
Permits to ride on freight trains.  
Special car passes.  
Refunding cash fares and tickets.  
Freight charges—employés' rate.
54. Foreign Lines—Competition:  
Competing and new railroad lines—schemes.  
Street railway lines—extension or proposed.  
Street railway lines—all matters.  
Competitive schemes.
55. Real Estate and Taxes:  
Purchase or sale of property.  
Right-of-way.  
Tax statements and matters.  
Repairs to buildings—walks, etc., outside property.  
Encroachments on company property or right of way.  
Internal revenue.
56. Mail Service:  
U. S. mail service—delays or detentions, fines.  
U. S. mail—weighing.  
U. S. mail—routes.  
Postoffice distances.  
R. R. mail—instruction and service.
57. Passenger Traffic:  
Excursion business—show troupes.  
Military service.  
Handling passengers.  
Stopping trains to accommodate passengers.  
Flag stops.

Express service—contracts and agreements.  
 Employés' express service.  
 Baggage department—rules, etc.  
 Board of health rules pertaining to baggage.

58. Freight Traffic:

Tonnage and ton mileage—statistics.  
 Proposed location of industries (except in connection with sidings).  
 Freight business from sundry industries.  
 Fast freight schemes—improvements.  
 Overloads—transferring—rules, etc.  
 Car carding and way bills.  
 Loading long shipments—instructions.  
 Shipments, ore.  
 Shipments, coal.  
 Shipments, coke.  
 Shipments, metal.  
 Shipments, limestone.  
 Shipments, live stock.  
 Shipments, box freight or merchandise.  
 Shipments, miscellaneous.

59. Car Service:

Car service—rules and decisions.  
 Car service meetings.

60. Sleeping and Parlor Car Service:

Union News and other train agencies.  
 Traffic agreements.  
 Sleeping and parlor cars—employés, conduct, etc.

61. Litigation—Cost of, etc.:

Attorney's fees and expenses.  
 Court costs.  
 Witness fees.  
 Attorneys—company.

62. Miscellaneous.

## REPORTS.

### LABOR REPORTS.

In 1901 the Committee took up the subject of a proper form of time book, and illustrated two different forms. The same subject has been further considered this year with a view to recommending a time book which could be used by any and all employés. Such a book is illustrated as follows:

A book of this character will accommodate 42 men. It is universally applicable for railroad work and may be used by track men, bridge men, water supply men, masons, engineer corps, inspectors and clerks. It combines a record of the time worked with a statement of what was actually done.

Objection is made by some to this form of time book on the ground that it requires too much writing on the part of the section foremen, many of whom are poorly educated and write very badly. The objectors

(Size of Book, 5" x 7  $\frac{3}{4}$ " )

## THE AMERICAN RAILWAY ENGINEERING AND MAINTENANCE-OF-WAY ASSOCIATION.

..... Division.

## TIME BOOK.

—OF—

Section No. ....

..... Foreman.

Headquarters .....

Month of ..... 190 .....

## INSTRUCTIONS.

1. Enter the information daily.
2. Read the instructions at the bottom of pages 2 and 3.
3. Show under each day the hours of work of each kind done, including work done by Foreman.
4. The Summary on pages 14 and 15 must show all the work done during the month. It is obtained by collecting the work done each day. Show separately work done on main tracks, sidings, new or construction work of all kinds, and for individuals or other companies.
5. The total hours each day must agree with the totals shown on pages 2, 3, 4, 5, 6 and 7.
6. The total of hours in Summary must agree with the total on page 7.

[illegible]

1. Spell names correctly. Write out first name and give middle initial. Enter check number in check number column.
2. Write "Paid by Certificate," when men have been so paid. If hired again, enter name a second time.

MONTH OF..... 190.....

[illegible]

3. Amounts due each man must be in even fives (5) or ten (10) cents.  
 4. Time of monthly men, not working a full month: Multiply the rate per month by the number of days worked (including Sundays and holidays), and divide by the total number of days in the month.

# RECORD OF WORK DONE ON DAYS OF THE MONTH.

DAY.	KIND OF WORK AND WHERE PERFORMED.	HOURS.
1		
2		
3		
4		
5		

## 15

DAY.	KIND OF WORK AND WHERE PERFORMED.	HOURS.
31		

### SUMMARY OF WORK DONE FOR MONTH.

[illegible]

**Foremen will not fill out the Dist. Column.**

**I certify the foregoing to be correct,**

\*\*\*\*\* Foreman.

Examined and approved,

.....Supervisor.

think that the best plan is to put as much as possible into print so that the foremen and others may not be subjected to the necessity of entering in their own handwriting a statement of the work actually done. On the other hand, it is claimed that this feature of this time book is an improvement, because it gives a record of the actual work done by the different classes of men, and if it is an actual record it should be accurate, and, therefore, a valuable record.

It has been found in practice that the daily distribution of the time of the different classes of men has been referred to many months after the work was actually done, with the result that proof was given as to what a particular gang of men did on a particular day.

This time book is of convenient size so that it may be carried in the pocket of the man who keeps the same. The book is intended to be carried with the gang each day and the record should be made up in the field. The paper should be of a character to permit the use of a pen.

On page 1 may be found the instructions to the men, and on page 15 a summary of the work done during the month.

It is believed that the best results will be obtained by having the men forward this book to their superior officer, the Supervisor, the Master Carpenter, or whoever that may be, at the close of the month; this superior officer would carefully check and examine the time book and approve the same; the book would then be forwarded to the office of the Engineer Maintenance-of-Way, where the pay roll would be prepared ready for the approval of the higher officers.

A distribution of each pay roll would be made up in the office of the Engineer Maintenance-of-Way from the summary which appears on pages 14 and 15, and this distribution would be forwarded through the proper officers to the Auditor.

The advantages incident to this system of handling time books are several, some of which are as follows:

The Supervisor or other officer is not burdened with much clerical work and his office is necessarily relieved in this respect. The time of the Supervisor can, therefore, be spent on the line where his services are much more important; in other words, the Supervisor is expected to spend his time constantly on the road with his men, examining the condition of the track, hurrying new work, etc.

The pay rolls and distribution sheets are made up in the office of the Engineer by competent clerks with much better results than would be otherwise obtained. Under this system the work is practically done but once, and, therefore, is no duplication. In this respect it is considered economical to use a book of this kind.

Further objection is made to this time book on the ground that section masters do not possess sufficient education to properly make up the book. The answer to this objection is this: If a railroad does not have section masters of sufficient education to keep such a simple record as this, they should employ men with greater ability. Railroads which now pay their section masters \$40.00 per month would do well to pay \$50.00

for better men, and railroads which pay \$50.00 per month had best raise their men to \$60.00, rather than have men so ignorant as to be unable to keep this simple record.

A section master is a responsible officer of any railroad, in charge of a certain definite length of road, and should possess a fair education. Rather than suit your time book to the character of the man, it would be better to increase wages and employ men with sufficient education to keep the record as it should be kept.

Another form of time book is illustrated below, this book being preferred by those railroads who employ section masters not possessing ability enough to keep the above record.

Sheet No. 1 below shows a front page for this time book. Sheet No. 2 shows form of monthly tie report to be printed on the back of the first leaf in the time book, and following this appear instructions to track foremen for distributing labor charges, with some notes on the first page in regard to the make-up of the time books.

#### NOTES ON TRACK TIME BOOKS.

Instructions for distributing labor can be printed on inside of both back and front cover.

The back of first leaf can be ruled for tie report, and of last leaf left blank for foreman's remarks or report on any work out of the ordinary performed on the section.

Books should be bound so as to answer for different sized gangs, and numbered thus:

Form 47-4, or Form 47-6, or Form 47-10, meaning 4, 6 or 10 men books.

#### INSTRUCTIONS TO TRACK FOREMEN.

At the close of each day's work enter the time of foreman and each man on the gang, dividing it according to the class of work done and chargeable to the various printed accounts in time books, as follows:

##### General Track Repairs:

Replacing occasional defective rails or fastenings, cutting and drilling rails, regauging, setting tie plates or rail braces. Shimming lining, ordinary surfacing. Taking up or moving sidetracks (but not extending them), and loading material from same for storage or shipment. Handling rails and fastenings for ordinary repair on Section. Collecting and shipping scrap iron from Section. Repairs to bumper posts on stub sidings.

##### Ditching and Widening Banks:

Widening and clearing out cuts and side ditches, offtake ditches, widening or raising dumps, repairing surface cross drains (but not culverts) under drains in cuttings.

##### Cutting Weeds and Brush:

Time spent weeding track, cutting grass, brush, and clearing rubbish off right of way and station grounds.

.....RAILROAD

ROAD DEPARTMENT

**TIME BOOK**

FOR SECTION No. ....

\_\_\_\_\_

*Mile Post* ..... *to Mile Post* .....

*Address* ..... *Station* .....

FOR MONTH OF

.....19.....

\_\_\_\_\_

Examined and Certified Correct

.....  
ROADMASTER

Foremen will note and carefully observe Instructions on Inside of Cover

<b>TRACK SEC. No.....</b>	<b>TIES USED FOR RENEWALS, ETC., DURING MONTH OF.....19....</b>
---------------------------	---

[illegible]

**Ties on Hand at First of Month**  
**" Received During the Month**

Total

### Ties Used in Main Tracks

" " " Slidings

**" Shipped Away or Used for Other Purposes**

**Balance on Hand at End of Month**

**Repairs to Switches and Frogs:**

Repairs to or replacing switch stands, head chairs, switch rods, frogs, guard rails, bolts, braces and slide plates, and stop blocks on side tracks.

**Renewal of Ties:**

Taking out old and putting in new track or switch ties, and tamping same, piling, burning or otherwise disposing of old ties.

**Renewal of Rails:**

Time occupied in unloading new rails and fastenings, removing old rails and replacing with new ones when relaying track, adzing ties, respacing and tamping joint ties, loading old rails, and fastenings for shipment.

**Damage by Flood or Freshet:**

Repairs to track banks, bridges and culverts. Watchmen or other labor caused by washouts or floods.

**Damage by Fire:**

Labor extinguishing fires, repairs to track, bridges and culverts, buildings, fences, etc., damaged by fire. Time of Watchmen at fires.

**Snow Expenses:**

Clearing snow or ice from track, station yards and platforms, culverts and ditches, men on snow plow or flangers, erecting and repairing snow fences of snow, slabs, ties or portable fencing, etc.

**Repairs Telegraph Lines:**

Time making repairs to lines and in giving notice to agents of the damage.

**Repairs of Fences, Cattle-guards and Road Crossings:**

Time repairing or renewing property line, fences, road or farm crossings and culverts under same, cattle-guards and wing-fences.

**Semaphore Signals and Track Signs:**

Attending to switch and semaphore lamps, repairs to semaphores and other signals, mile boards and all track signs.

**Repairs to Bridges and Culverts:**

Time making repairs to bridges, box culverts and pipe drains underneath tracks, and assisting carpenters at same, filling water barrels on bridges. (Give number of bridge.)

**Water Supply:**

Furnishing water for locomotives, either pumping at tanks, bailing, snowing or otherwise. (Always give name of tank and number of locomotive.)

**Station Service and Expenses:**

Handling freight at stations, cleaning out stock yards and stock cars. (Give name of station, and initials and number of cars.)

**Damage to Stock:**

Removal and disposing of animals killed or injured on track, notifying owners or attending as witnesses in suits on account of damage.

**Wrecking:**

Working at wrecks, repairing track, roadbed and bridges damaged by wreck, watching or reloading freight, time occupied in giving notice of wrecks. (Give location of wreck.)



REMARKS.

**New Work:**

Enter time employed ballasting tracks, laying pit tracks, building new sidings or extending old ones, new fencing, cattle-guards, crossings, bridges or any other class of work not strictly a repair to or renewal of existing structures, on the blank lines at the bottom of the page, and state clearly on what class of work each man was engaged, and describe its location.

Sheet No. 4 shows a Road Department distribution of labor, to which the totals of each account in the time books is transferred.

Sheet No. 5 shows a form of ruling for a book for an office record, giving the total expenditure under each account for each Roadmaster's division each month of the year, with the average annual cost per mile of each account.

**MATERIAL REPORTS.**

The Committee submits to the Association the following blank as a standard Material Report, to be used by track foremen each month in reporting material on hand, material received during the month, material taken out of track and material used during the month on new work or on repairs of main track and sidings, and such material as was shipped away from one division to another.

The Committee believes that there should be one uniform blank for the Track Department and one uniform blank for the Bridge and Building Department. The latter blank has not been considered by the Committee this year.

The attention of the Association is called to the advantages of the blank which is now submitted. Its size is standard,  $8\frac{1}{2} \times 14$ . It is small and yet large enough for the purpose. Some roads use a much larger blank than this, which involves a larger expenditure of money for stationery.

This blank shows all the information which is desired and provides on the reverse side for such remarks as are necessary to explain exactly where material was used. The Committee does not recommend this blank except as a general form.

The first column, Kind of Material, may be varied to suit the different requirements of the roads, but the Committee does believe that the ruling of the blank and its headings are the best that can be designed. The blank is intended to be used as follows:

On a specified day in the month, whether that be the last day, the first day or the fifteenth day of each month, the track foreman makes up this report and forwards the same to the Supervisor of Track, his superior officer; the Supervisor carefully examines the same, and when he finds it to be correct, forwards it to the office of the Engineer Maintenance-of-Way, having marked the same "Examined and Approved," John Blank, Supervisor. Before sending this report from his office he makes up a complete statement of all material on his division, this latter statement to be retained in his office as a record for his guidance during the month.

The Material Clerk in the office of the Engineer Maintenance-of-Way takes charge of the work in connection with consolidating the different

**SHEET No. 4.**

**RAILROAD COMPANY:** \_\_\_\_\_ **Division:** \_\_\_\_\_

**ROAD DEPARTMENT:** \_\_\_\_\_ **Distribution of Pay Roll:** \_\_\_\_\_ 19\_\_

**Section:** \_\_\_\_\_

Account Unavailable	Month												Total	Total	Total
	1	2	3	4	5	6	7	8	9	10	11	12			
General Track Repairs.															
Ditching and Widening Banks.															
Cutting Weeds and Brush.															
Repairs to Switches and Frogs.															
Renewal of Ties.															
Renewal of Rails.															
Damage by Flood.															
Damage by Fire.															
Snow Expenses.															
Repairs of Telegraph Lines.															
Repairs of Fences and Cattleguards.															
Repairs of Track Signs.															
Repairs of Semaphores and Signals.															
Repairs of Bridges and Culverts.															
Water Supply.															
Station Service and Expenses.															
Damage to Stock.															
Wrecking.															
<b>Total of Operating Expenses.</b>															
<b>Total of Pay Roll for Mech Gang.</b>															
<b>Correct:</b>															

*Figures for this column are calculated on percentage basis.*

*Place columns for additional sections, yard gang and fire gang.*

*Place to be for 31 days.*

Approved: \_\_\_\_\_  
Chief Engineer

SHEET No. 8. RAILROAD.  
Road Dept. Distribution of Labor for the Year 19--

Division.

Accounts Chargeable.	Jan.	Feb.	Mar.	Apr.	May	June	July	Aug.	Sept.	Oct.	Nov.	Dec.	Total.	Average per Month per Annum.
Miles Operated.														
General Track Repairs														
Ditching and Widening Banks														
Cutting Weeds and Brush														
Repairs to Switches and Frogs														
Renewal of Ties														
"    " Rails														
Damage by Flood or Freshet														
"    " Fire														
Snow Expenses														
Repairs Telegraph Lines														
"    " Fences, Cattleguard and Rd. Crossings														
Semaphores, Signals and Track Signs														
Repairs to Bridges and Culverts														
Water Supply														
Station Service and Expenses														
Damage to Stock														
Wrecking														
Other Operating Expenses														
Total Operating Expenses														
Av. Cost per Mile Each Month														
Space for Cost of Labor on New Work, Various periods's accounts and accounts not chargeable to operating.														
Total of Pay Rolls														



# THE AMERICAN RAILWAY ENGINEERING AND MAINTENANCE-OF-WAY ASSOCIATION.

## CHIEF ENGINEER'S DEPARTMENT.

Report of Siding \_\_\_\_\_ on \_\_\_\_\_ Division,  
 At \_\_\_\_\_ Station, Survey Station \_\_\_\_\_ + \_\_\_\_\_ to \_\_\_\_\_ + \_\_\_\_\_  
 Name of Siding \_\_\_\_\_ 19 \_\_\_\_\_

	TOTAL LENGTH INCLUDING SWITCHES	LENGTH IN CLEAR	AMOUNT OWNED BY		NAME OF OTHER OWNER
			RAILROAD CO.	OTHERS	
Present	.....	.....	.....	.....	.....
Former	.....	.....	.....	.....	.....
Extension	.....	.....	.....	.....	.....
Taken up	.....	.....	.....	.....	.....

Fill in blank space after the words "Report of Siding" with one of the following: "Laid,  
 "Extended" or "Taken Up."  
 Give authority for statement as to ownership

Make sketch of location in black ink and show siding referred to in red ink--sketch should give  
 frog number, length of lead and location of siding from main track.

The  
 American Railway Engineering  
 and  
 Maintenance-of-Way  
 Association.

CHIEF ENGINEER'S DEPARTMENT.

## REPORT OF SIDING.

Division \_\_\_\_\_  
 At \_\_\_\_\_ Station  
 Name of Siding \_\_\_\_\_  
 Month \_\_\_\_\_ Day \_\_\_\_\_ 19 \_\_\_\_\_

## TYPICAL FORM OF AGREEMENT FOR SIDETRACKS TO INDUSTRIES.

Your Committee having been requested by a member of this Association to submit a typical form of agreement covering the construction and maintenance of sidetracks to industries, has complied with the request, and submits two forms herewith.

Your Committee is of the opinion that the making of the forms referred to lies with the Legal Department of the transportation line, rather than with the various departments represented in the membership of this Association, and the typical forms suggested should first receive the sanction of that department before being adopted by this Association.

Two types are submitted: One type which may be used where more or less elasticity is desirable, and the agreement is the result of a trade, and the other where trading is neither necessary nor desirable.

In compiling the forms, it has been the intention to make them as concise as possible, while covering all of the questions that are likely to arise between the two parties in their special relations to each other, and it is hoped that all of the provisions may be enforced in law.

ARTICLES OF AGREEMENT	BETWEEN	THE AMERICAN RAILWAY ENGINEERING	.....	.....	.....	.....	.....
	AND	MAINTENANCE-OF-WAY ASSOCIATION	.....	.....	.....	.....	.....
	AND		.....	.....	.....	.....	.....
			.....	.....	.....	.....	.....
			.....	.....	.....	.....	.....
	Dated.....						
	RELATING TO						
	Sidetrack at.....						

## FORM I.

THIS AGREEMENT, made this.....day of.....in the year 19...., between.....Company, operating the.....as first party, and.....as second party, witnesseth:

WHEREAS, The second party desires the construction of a sidetrack situate.....in the county of....., State of..... Said sidetrack to be connected with the.....track of the.....aforesaid on the.....side thereof, extending.....wardly about.....of which about.....shall be on the land of first party, and about.....on land owned or controlled by the second party.

Now, therefore, it is agreed between the parties, that the first party will construct said sidetrack as above indicated, upon the following terms and conditions:

1. That said first party will furnish the rail, switches, frogs, bolts and splices required in the construction of said sidetrack.

2. That said second party will furnish the right of way and structures required to complete the roadbed to subgrade ready for track, do all grading, and will, if necessary, obtain and furnish said first party with the written consent or permission from the proper authorities for said first party to construct, maintain and operate said sidetrack across any highways or other public lands or property.

3. That said second party will furnish the ties and timbers necessary for the construction of said track, and will pay to said first party the amount expended for the labor of putting in the track over or upon the land owned by either party.

4. That said second party will furnish and deposit with the..... of said first party, a certified check, payable to....., covering the estimated cost of labor to be furnished by said first party in building said track for said second party; and after said sidetrack is laid, said second party will pay to said first party, within thirty days after presentation of bills therefor, the entire cost of all labor furnished by said first party in the construction of said track. The certified check as hereinabove required will apply on this account.

5. That said second party will pay to said first party, for the use of said sidetrack the sum of.....per annum; said sum being..... per cent interest per annum on the cost of the material furnished by said first party in the construction of said track. Said rental to be paid..... in advance.

Said sidetrack shall be maintained by the first party, and the cost thereof shall be borne by said second party.

The ownership of the materials in said track shall be vested in the party furnishing them.

The second party agrees that, without the written consent of the first party, it will not direct or authorize the use of said track by or for the benefit of any other party not one of the parties hereto.

The second party agrees to exercise the greatest care in the management of the siding herein provided for, to prevent cars or other obstructions from getting out upon or too close to the main or other tracks, to secure the safe closing and locking of the main switch, or switches, and to keep the inner safety switch (where such switch is provided) in proper position; also, to use such means and care generally as will tend to avoid accidents of any kind.

The second party agrees that the first party shall have the privilege of using said track free of charge; provided, however, that such use shall not materially interfere with the business of said second party. In case it is desired by other persons engaged in business in the vicinity of said sidetrack to connect therewith, or to extend the same by building additional tracks from said sidetrack to their own premises, that such other persons shall have the right to make such connection and to use the said track upon paying therefor such sum to the second party as rental as may be deemed reasonable by the.....of the first party.

The said second party hereby agrees that it will execute no mortgage or other lien upon the portion of land or right of way upon which said track is laid, which will become a lien upon the rails, switches, frogs, fastenings, switch-ties and other material furnished and owned by said first party.

In further consideration of the advantages and benefits to accrue to said second party on account of the location and operation of the said sidetrack by the first party, it is further agreed that the said second party will indemnify, protect and save harmless said first party against loss and

damage or expense by fire to cars and contents standing upon said siding which have been placed there for use of said second party. And said second party hereby releases said first party from all claims of whatsoever character for damages resulting to the property of said second party by reason of fire originating from the engines and locomotives of the first party and resulting in the burning or destruction of or injury to the property of the second party.

It is further understood and agreed that for any default of the second party in any of its agreements expressed in this contract, or for any failure to perform any of its undertakings as set forth, the first party may terminate this contract by giving said second party thirty days' notice in writing of such termination. It is further agreed between the parties that said.....company shall have the right to terminate this contract at any time during the term, by giving sixty days' notice in writing to said second party thereof; and it is further provided that should the right of said first party to the materials furnished for said track be questioned, clouded or imperiled by adverse and hostile claim, threatened sale or legal proceedings, said first party may, on giving five days' notice, proceed at once to take up and remove said track.

This contract shall continue for the term of.....years from the.....day of....., 19...., subject to cancellation as aforesaid.

..... Lessor of said second party, hereby approves and adopts the foregoing agreement as his own, as far as relates to himself.

IN WITNESS WHEREOF, the parties hereto have caused these presents to be executed by their duly authorized officers the day and year first above written. Executed in duplicate, each party to retain a copy.

The.....Company,  
By.....  
.....  
.....Lessor.

NOTE.—In case the ground is occupied by a tenant. Instead of owner, insert name of owner in final paragraph, preceding the attesting clause before the words "Lessor of said second party;" otherwise strike out such final paragraph. In every case this agreement should be signed by the owner of the fee and of the leasehold where there is a tenant.

#### FORM II

THIS AGREEMENT, made this.....day of.....in the year 19...., between.....company operating the.....as first party, and.....as second party, witnesseth:

WHEREAS, The second party desires the construction of a sidetrack situate.....in the county of.....State of..... Said sidetrack to be connected with the.....track of the.....aforesaid on the.....side thereof, extending.....wardly about.....of which about.....shall be on the land of first party, and about.....on land owned or controlled by the second party.

Now, therefore, it is agreed between the parties, that the first party will construct said sidetrack as above indicated, upon the following terms and conditions:

(Space for terms and conditions.)

Said sidetrack shall be maintained by the.....party, and the cost thereof shall be borne.....

The ownership of said track shall be vested as follows: .....

The second party agrees that, without the written consent of the first party, it will not direct or authorize the use of said track by or for the benefit of any other party not one of the parties hereto.

The second party agrees to exercise the greatest care in the manage-

ment of the siding herein provided for, to prevent cars or other obstructions from getting out upon, or too close to the main or other tracks, to secure the safe closing and locking of the main switch, or switches, and to keep the inner safety switch (where such switch is provided) in proper position; also, to use such means and care generally as will tend to avoid accidents of any kind.

The second party agrees that the first party shall have the privilege of using said track free of charge; provided, however, that such use shall not materially interfere with the business of said second party. In case it is desired by other persons engaged in business in the vicinity of said sidetrack to connect therewith, or to extend the same by building additional tracks from said sidetrack to their own premises, that such other persons shall have the right to make such connection and to use the said track upon paying therefor such sum to the second party as rental as may be deemed reasonable by the..... of the first party.

The said second party hereby agrees that it will execute no mortgage or other lien upon the portion of land or right of way upon which said track is laid, which will become a lien upon the rails, switches, frogs, fastenings, switch-ties and other material furnished and owned by said first party.

In further consideration of the advantages and benefits to accrue to said second party on account of the location and operation of the said sidetrack by the first party, it is further agreed that the said second party will indemnify, protect and save harmless said first party against loss and damage or expense by fire to cars and contents standing upon said siding which have been placed there for use of said second party. And said second party hereby releases said first party from all claims of whatsoever character for damages resulting to the property of said second party by reason of fire originating from the engines and locomotives of the first party and resulting in the burning or destruction of or injury to the property of the second party.

It is further understood and agreed that for any default of the second party in any of its agreements expressed in this contract, or for any failure to perform any of its undertakings as set forth, the first party may terminate this contract by giving said second party thirty days' notice in writing of such termination. It is further agreed between the parties that said .....Company shall have the right to terminate this contract at any time during the term, by giving sixty days' notice in writing to said second party thereof; and it is further provided that should the right of said first party to the materials furnished for said track be questioned, clouded or imperiled by adverse and hostile claim, threatened sale or legal proceedings, said first party may, on giving five days' notice, proceed at once to take up and remove said track.

This contract shall continue for the term of.....years from the .....day of.....19...., subject to cancellation as aforesaid.

....., Lessor of said second party, hereby approves and adopts the foregoing agreement as his own, as far as relates to himself.

IN WITNESS WHEREOF, the parties hereto have caused these presents to be executed by their duly authorized officers the day and year first above written. Executed in duplicate, each party to retain a copy.

The.....Company,  
By.....  
.....  
.....Lessor.

NOTE.—In case the ground is occupied by a tenant instead of owner, insert name of owner in final paragraph, preceding the attesting clause before the words "Lessor of said second party;" otherwise strike out such final paragraph. In every case this agreement should be signed by the owner of the fee and of the leasehold where there is a tenant.

## FORM III.

The following blank contract has a number of good features, which are as follows:

First—The individual, otherwise known as the shipper, furnishes all the money for the original construction of a siding; therefore, the burden falls on the shipper rather than the railroad company. It is believed that the burden should naturally rest on the shipper, as otherwise the tendency of the manufacturer would be to demand more shipping facilities than required.

If the shipper is required to put up the entire first cost of a sidetrack, with the understanding that the company will eventually buy back a part of this track, he will have a direct interest in furnishing traffic to the company.

Second—This agreement provides that the shipper shall receive in rebates at the rate of \$1.00 per car the entire amount of the first cost of the track. This feature of the agreement encourages traffic and virtually makes the shipper a present of the siding, as far as the same is on his land, after he has furnished a sufficient amount of freight at the rate of \$1.00 per car to cover the entire first cost of the track.

Third—After the first cost has been rebated to the shipper, the ownership of the siding is determined by the ownership of right-of-way—that portion of the track on railroad property being owned by the railroad, and that portion of the track on the property of the individual being owned by the shipper. Each party maintains his own portion of the track.

It is believed that this feature is an excellent one, because thereafter the shipper must stand the burden of the expense of maintenance of all the track on his property. Experience in those portions of our country where the coal, coke and limestone business is heavy would tend to indicate that this was a practice very much in the interests of railroad companies.

Fourth—The contract contains the further usual provisions that the shipper will not permit any other railroad to connect with this sidetrack; that the railroad will have a right to use the track for other business than that of the individual shipper, and that the individual will conform to certain definite clearances in building structures at the side or over said track.

FOR AND IN CONSIDERATION of the conditions and agreements herein contained, the American Railway Engineering and Maintenance-of-Way Association, party of the first part, agrees to furnish all the material for, construct and operate a sidetrack desired by ..... party of the second part, connecting with its railroad and extending to and upon premises owned or controlled by said second party, at ..... substantially as shown upon blue print, attached hereto and made a part hereof, by the lines marked.

Provided, however, that said second party agrees to furnish the right-of-way and structures required to complete the roadbed to sub-grade ready for track, do all grading, and will, if necessary, obtain and furnish said first party with the written consent or permission from the proper author-

ities for said first party to construct, maintain and operate said sidetrack across any highways, etc., and said second party will also furnish and deposit with the Treasurer of said first party a certified check, payable to said Treasurer, covering the estimated cost of labor and material to be furnished by said first party in building said track for said second party; and after said sidetrack is laid, said second party will pay to said first party within thirty days after presentation of bills therefor the entire cost of all labor and material furnished by said first party in the construction of said track. The certified check as hereinabove required will apply on this account. It is, however, understood and agreed that said first party shall and will allow to said second party one dollar (\$1.00) per carload of freight forwarded or received over said sidetrack (switch business not to be included), until the whole amount so allowed shall equal the total amount of the bills paid by said second party to said first party for labor and material furnished by said first party in construction of said tracks.

It is further understood and agreed by the parties hereto that the party of the first part shall own and maintain that portion of said sidetrack that is located on its right-of-way; and that the party of the second part shall own and maintain the balance of said track.

The first party shall have the right to use, without cost, the whole or any part of said track for other business than that of the second party, when the same is not actually occupied by cars which are being loaded or unloaded by the second party, and the second party hereby agrees to allow access to said siding over its property for this purpose.

The second party further agrees that it will not permit any other railroad company to connect its tracks with the proposed sidetrack. The second party agrees to exercise the greatest care in the use of the tracks herein provided for; to prevent cars or other obstructions from getting out upon, or too close to, the main or other tracks; to secure the safe closing and locking of all switches on land of second party; also, to use such means and care generally as will tend to avoid accidents of any kind; and said second party further agrees that it will not place or permit to be placed or erected any structure of any kind whatever within the space of five (5) feet from either rail of said sidetrack, and that if any building or other structure of any kind whatever is erected above rails of said sidetrack, that the same shall not be placed nearer to the tops of the rails of said sidetrack than twenty-one (21) feet.

This agreement may be terminated at any time upon sixty (60) days' written notice of either party to the other of its desire to terminate the same, and at any time after the expiration of said sixty (60) days' written notice, said first party may take up and remove said sidetrack, with all appurtenances connected therewith, and the same shall be divided between the parties according to their respective interests therein.

....., lessor of said premises to the second party, hereby assents to, approves and affirms the foregoing agreement and grant of rights and privileges to the first party, in, to and upon said lands and premises, and to remove said tracks, and the limitations and restrictions as to the use thereof and connections therewith.

IN TESTIMONY WHEREOF, the parties hereunto have caused this agreement to be executed, in duplicate, this ..... day of ....., A. D. 190...

## WITNESSES:

The American Ry. Eng. and Maint.-of-Way Assn.  
 ..... By .....  
 Vice-President and General Manager.  
 ..... By .....

## ACCOUNTS.

The classification of construction and operating expenses, recommended by the Interstate Commerce Commission and the Association of American Railway Accounting Officers, should be followed as closely as possible. These classifications are as follows:

## CLASSIFICATION OF CONSTRUCTION EXPENSES.

- |   |                                     |
|---|-------------------------------------|
| 1. Engineering.                         | 16. Telegraph Lines.                |
| 2. Right-of-Way and Station Grounds.    | 17. Station Buildings and Fixtures. |
| 3. Real Estate.                         | 18. Shops, Roundhouses, Turntables. |
| 4. Grading.                             | 19. Shop Machinery and Tools.       |
| 5. Tunnels.                             | 20. Water Stations.                 |
| 6. Bridges, Trestles and Culverts.      | 21. Fuel Stations.                  |
| 7. Ties.                                | 22. Grain Elevators.                |
| 8. Rails.                               | 23. Storage Warehouses.             |
| 9. Track Fastenings.                    | 24. Docks and Wharves.              |
| 10. Frogs and Switches.                 | 25. Electric Light Plants.          |
| 11. Ballast.                            | 26. Electric Motive Power Plants.   |
| 12. Track Laying and Surfacing.         | 27. Gas-Making Plants.              |
| 13. Fencing Right-of-Way.               | 28. Miscellaneous Structures.       |
| 14. Crossings, Cattle Guards and Signs. | 29. Legal Expenses.                 |
| 15. Interlocking or Signal Apparatus.   | 30. Interest and Discount.          |
|   | 31. General Expenses.               |

## CLASSIFICATION OF OPERATING EXPENSES

## I. MAINTENANCE OF WAY AND STRUCTURES.

1. Repairs of Roadway.
2. Renewals of Rails.
3. Renewals of Ties.
4. Repairs and Renewals of Bridges and Culverts.
5. Repairs and Renewals of Fences, Road Crossings, Signs and Cattle Guards.
6. Repairs and Renewals of Buildings and Fixtures.
7. Repairs and Renewals of Docks and Wharves.
8. Repairs and Renewals of Telegraph.
9. Stationery and Printing.
10. Other Expenses.

## II. MAINTENANCE OF EQUIPMENT.

11. Superintendence.
12. Repairs and Renewals of Locomotives.
13. Repairs and Renewals of Passenger Cars.
14. Repairs and Renewals of Freight Cars.
15. Repairs and Renewals of Work Cars.
16. Repairs and Renewals of Marine Equipment.
17. Repairs and Renewals of Shop Machinery and Tools.
18. Stationery and Printing.
19. Other Expenses.

## III. CONDUCTING TRANSPORTATION.

20. Superintendence.
21. Engine and Roundhouse Men.

22. Fuel for Locomotives.
23. Water Supply for Locomotives.
24. Oil, Tallow and Waste for Locomotives.
25. Other Supplies for Locomotives.
26. Train Service.
27. Train Supplies and Expenses.
28. Switchmen, Flagmen and Watchmen.
29. Telegraph Expenses.
30. Station Service.
31. Station Supplies.
32. Switching Charges—Balance.
33. Car Mileage—Balance.
34. Hire of Equipment.
35. Loss and Damage.
36. Injuries to Persons.
37. Clearing Wrecks.
38. Operating Marine Equipment.
39. Advertising.
40. Outside Agencies.
41. Commissions.
42. Stock Yards and Elevators.
43. Rents for Tracks, Yards and Terminals.
44. Rents of Buildings and Other Property.
45. Stationery and Printing.
46. Other Expenses.

#### IV. GENERAL EXPENSES.

47. Salaries of General Officers.
48. Salaries of Clerks and Attendants.
49. General Office Expenses and Supplies.
50. Insurance.
51. Law Expenses.
52. Stationery and Printing (General Offices).
53. Other Expenses.

All the accounts of the Maintenance-of-Way and Construction Departments should correspond with these classifications, and yet the different classifications are so flexible as to permit of the fullest modification to suit the requirements of the different Managing Officers without detriment to the general result.

The different headings may be further subdivided to suit the local requirements of each individual company. However, the general principle to be followed is this: Make up the accounts to correspond in general with this standard classification, and have it clearly understood that any blanks which are used should contain such information as would permit accounts to be made according to this classification.

A further principle to be followed in connection with accounts is to make up the accounts just once. In order to do this all the data ascertained from the several blanks used by the Track Foremen and the Supervisors in making their reports should be consolidated in the office of the Engineer Maintenance-of-Way. This office should prepare such reports as may be required by the Auditor, forwarding the same through whatever channels may be deemed proper. Such a system is economical in reducing the amount of labor expended in reaching results.

## SUGGESTIONS.

The work of this Committee in the future will be very much aided by the members of this Association if they will make it a rule to submit to the Secretary of the Association at different times during the year, when necessity arises, such questions as they may think proper pertaining to matters arising in every day practice.

These questions in turn should be submitted by the Secretary to the Committee for their consideration. In this way, and probably only in this way, will the Committee be informed as to the exact needs of the members of the Association as respects Records, Reports and Accounts, and when these needs are known it should be the aim of the Committee to collect data on the subject submitted and reach some conclusion as to what would be best practice.

The Committee desires to do that work which will yield the best results to the Association, and trusts that the members of the Association will make known their needs from time to time.

## CONCLUSIONS.

1. **LABOR REPORTS.**—The Committee illustrates two forms of labor reports above, but makes no recommendation at this time. Attention is called to the system according to which the time book should be used; that is to say, the time book should be made up by the track foreman, forwarded by him to the Supervisor, or Roadmaster, examined and approved by him and in turn forwarded to the office of the Engineer Maintenance of Way, or General Roadmaster.

The Engineer's office should retain this time book as a permanent record for a proper length of time. The pay-roll and the distribution of labor expense should be prepared by the Engineer's office from this time book, these pay-rolls and distributions being forwarded to the Auditor through the proper approving officers.

2. **MATERIAL REPORTS.**—The Committee recommends the material blank for use of section masters, which blank is illustrated above. Said blank is small, yet very complete, and gives all necessary information to enable a complete check to be had on all material used.

The blank should be used according to the same system as outlined for labor reports, viz.: the report being originally made up by the track foreman, forwarded to the Supervisor, who checks the same and in turn forwards it to the office of the Engineer, where all accounts are made up.

3.—Complete records of bridges should be kept, which would show the information outlined above. However, this subject is so large and important as to require further study on the part of the Committee before recommending in detail any specific blank.

It should be the aim of the Committee to continue its consideration of this subject for at least two more years, and to submit each year a progress report.

4.—It is believed that the system described for filing maps, plans, etc., above illustrated, is the best that is known at the present time. The card index system is excellent.

5.—The Committee makes no recommendation regarding form of contract for sidings to industries, because each railroad does business under conditions peculiar to itself. However, it is believed by the Committee that the third contract above illustrated is the ideal contract to be used, especially where there is any doubt regarding the ability of the shipper to furnish traffic.

6.—While the above system for filing correspondence will be found excellent, yet this subject is one on which the Committee makes no recommendation at this time, in view of the fact that this subject is worthy of a much more extended investigation than the Committee has been able to make.

7.—Under the head of Accounts, including both labor and material accounts, the Committee is of the opinion that the classification and distribution of the same should be confined as closely as possible to the system of the Interstate Commerce Commission.

Each heading may be further subdivided, but the fewer subheads the better.

8.—As a general proposition the Committee submits the above as a progress report.

Respectfully submitted,

F. E. BISSELL, L. S. & M. S., Cleveland, *Chairman*;  
 EDWIN F. WENDT, P. & L. E., Pittsburg, *Vice-Chairman*;  
 L. F. GOODALE, Burlington's Mo. Lines, St. Louis;  
 ROLAND WOODWARD, J. & S.-W., Jacksonville, Fla.;  
 E. K. WOODWARD, Wabash, Detroit, Mich.;  
 G. H. WEBSTER, Can. Pac., Montreal Can.;  
 H. ROHWER, Mo. Pac., St. Louis, Mo.;  
 T. J. FRAZIER, B. & O., Zanesville, O.;  
 F. L. NICHOLSON, Norfolk & Southern, Norfolk, Va.;  
 GEORGE HOULISTON, Penna., Buffalo, N. Y.

*Committee.*

Mr. Edwin F. Wendt (Pittsburg & Lake Erie):—The Committee on Records, Reports and Accounts submits a few conclusions. On page 45 we substitute the word "conclusions" for the word "recommendations," the Committee having made this change in the report. You will also note that our eighth conclusion is as follows: "As a general proposition the Committee substitutes the above as a progress report." We wish the Association to consider this as such a report. No recommendations, in the usual sense in which recommendations are understood, are made. Certain conclusions have been arrived at by the Com-

mittee, and we ask the Association to consider these conclusions without reference to their adoption. In order to bring the matter to a discussion at once, the Committee asks the Association to express its views at this time on the paragraph on page 45 of the report, headed "Suggestions."

Chairman McDonald:—We shall be glad to hear from any of the members on the subject of these suggestions. It is probably true that the members have not had time to read the voluminous report which has been presented. I think they will find at a glance there are some valuable data in it, and it will be understood, unless there is further discussion on the subject, that the members will apply to the Committee for what information they desire, and we will pass to the next matter which the Committee wishes us to discuss.

Mr. Wendt:—The Committee will be pleased to have the conclusions taken up, one at a time, bearing in mind that the Committee does not desire to be understood as recommending anything for final decision. The subject is one which will require much more study than has been given to it, and the subject also deserves very careful and very extended study. The Committee in its first conclusion says:

"1. LABOR REPORTS.—The Committee illustrates two forms of labor reports above, but makes no recommendation at this time. Attention is called to the system according to which the time book should be used; that is to say, the time book should be made up by the track foreman, forwarded by him to the Supervisor or Roadmaster, examined and approved by him and in turn forwarded to the office of the Engineer Maintenance-of-Way or General Roadmaster.

"The Engineer's office should retain this time book as a permanent record for a proper length of time. The pay-roll and the distribution of labor expense should be prepared by the Engineer's office from this time book, these pay-rolls and distributions being forwarded to the Auditor through the proper approving officers."

Chairman McDonald:—I presume in the first conclusion it is meant in case there is no engineer of maintenance, and the division superintendent has charge of maintenance, the reports shall be made to him.

Mr. Wendt:—The Committee received criticism in regard

to the subject of titles. There is considerable difference in this matter in the various parts of the country. The duty of harmonizing titles, of course, belongs to the Committee of Organization and Uniform Rules. In this connection I may say that we desire to make a change on page 16, under the heading, "Labor Reports." We desire that the second sentence in the first paragraph shall read as follows: "The same subject has been further considered this year and one form of a book is illustrated and described below." The Committee has carefully cut out anything that would seem to make a positive recommendation.

We want to ask the Association a question for information. We have included on page 24 "Instructions to Track Foremen." We recognize that such instructions are necessary in order to explain how the blanks should be used. The question arose as to whether it was the province of this Committee to make up a complete set of instructions to track and bridge men, men engaged in maintenance of way. We would like to get the sense of the members on this proposition.

Mr. J. H. Abbott (Baltimore & Ohio):—It would seem to me that this Committee should have, and ought to make up, rules governing the use of the different forms of records, books and accounts, so far as related to the records, reports and accounts. It is absolutely necessary to have some set of rules in order to obtain what the forms are designed to secure, but I would say, so far as relates to rules of work, or matters pertaining to the kind and character of work to be done, such a book of instructions they should have nothing to do with, but they should make up such rules as are required to secure such records and accounts as are desired.

Mr. I. O. Walker (Nashville, Chattanooga & St. Louis):—On page 19 the form shows there is a sort of journal attached to the time book. Is that right?

Mr. Wendt:—Page 19 is page 8 of the time book illustrated, and is a journal. It is incorporated in the time book—it is part of it, and is used each day by the foreman in charge of the men in recording the exact nature of work done and the number of hours spent on each subdivision of work.

Chairman McDonald:—We must not lose sight of the request made by the Committee for expression of opinion as to the prov-

ince of this Committee to draw up rules, and we would like a full discussion on that point from the membership.

Mr. W. M. Camp (Railway and Engineering Review) :—In reference to labor reports, there is a matter which sometimes gives the section foreman trouble, and that is checking the column of totals. A foreman is usually paid by the month, and gets his full monthly pay whether there are any rainy days or not, but in a great many time books the instructions call for putting down the time actually worked by him, as well as the time during which the men actually work. In order to check up the totals, it is necessary to leave the foreman's pay out of consideration. Taking the total number of days worked by the men and multiplying that by the price per day, the report will check if you leave the foreman's pay out of consideration. I know that some roadmasters instruct their foremen to take a general average, but you cannot make it check that way. I think it might be well if the Committee would formulate a rule to cover that point.

Mr. Walker :—I think it may be stated as a general proposition that south of the Ohio River we never use anything but nickels in computing time. It is used on our system, on the Louisville & Nashville, and several others. I would ask if it is the intention that the time book shall be used for only one month?

Mr. Wendt :—It is the intention that the time book shall be used for only one month, and at the close of the month it becomes a part of the records of the roadmaster or the division engineer.

Mr. Walker :—I think this journal idea is excellent. I could never get it into operation, although I have tried to do it. It adds something to the expense of the book, perhaps 5 cents per dozen, but we are using now, and have been for some time, a report which leaves the description of the work entirely to the men, shows the number of men at work, the number of hours of one man on the work, and the description of the work. It is designed to be reasonably accurate. It is a weekly report which is sent in for the week ending Saturday night, and gives the roadmaster, or the bridge supervisor, or whoever has the work in charge, an idea of what is going on during the week. It is simple and does not tax the foreman to make it up, and yet we get a considerable amount of information from it.

Mr. Camp:—The last “week” of the month is usually a period of about ten days; it completes the four “weekly” reports that have to be footed up at the end of the month and checked with the full monthly report. But these four so-called “weekly” reports are for unequal periods. For instance, the first weekly report will cover the time until the night of the 7th, the second until the 14th, the third until the 21st, and the fourth until the 30th or the 31st, and thus the last of the four is a report for ten days, and it is not an easy mental operation to compare the data of that report with those of the three other reports for periods of seven days each. I think it is better practice to make reports every ten days, and then you have reports of equal or nearly equal periods. Suppose they are made out on the 10th, the 20th and last day of the month. The periods reported upon are then equal for about half of the months, and for the months having 31 days they are nearly equal, and always more readily comparable than it is possible to have them when they are made out four times each month. It would be well, I think, to consider whether it would not be better to make three reports a month, rather than four.

Chairman McDonald:—We hope the Committee will take these things under consideration. We will revert to the Committee's request to consider their province in the preparation of the book of rules. The opinion of the chair is that it does not fall within the province of this Committee.

Mr. W. J. Harahan (Illinois Central):—It seems to me that the Committee will have to make the rules. If not, the committee that does make them will have to consider all of these blanks and consider about the same matter which has come before this Committee in framing the rules. Another thing in connection with this report is that they are likely to run foul of the auditing department in some places. There are many features in the report which relate to the auditing department, and it would seem wise that this matter be taken up with the Auditors' Association when trying to get a set of rules that will be acceptable to everyone. For instance, in the report the time book is shown to be under the control of the roadmaster. On our system the time books are held by the auditor, as a matter of record to the auditing department, and I do not think we will get uniform results

unless we take this matter up with the auditing department and try to cover the whole subject in that way.

Chairman McDonald:—We cannot get uniform accounts and uniform forms until we have uniform organization. I imagine that each organization will find something in this book which will be useful.

Mr. W. L. Breckinridge (Chicago, Burlington & Quincy):—I think the matter of rules might come under the jurisdiction of the Committee on Track. I would be glad to hear from some member of that Committee who has considered the matter.

Mr. Camp:—I understand the question is whether the Track Committee has considered the question of rules. The Committee has not done so to my knowledge.

Chairman McDonald:—It would appear to me that it would be the province of the Committee on Bridges to prepare rules for the government of employés on bridges, and the Committee on Track to prepare rules for employés on the track. The Committee on Records, Reports and Accounts would probably have to act in conjunction with them, and finally these committees would have to confer with each other before they could arrive at a standard book of rules which will agree with all their forms. I think the Committee would like an expression from the membership as to whether they are expected to prepare this book of rules or not.

Mr. Walker:—What I understand this Committee is after is to discover whether they shall be instructed to formulate a set of rules simply applying to reports. Is that the idea?

Chairman McDonald:—My understanding of the request is that they desire to know whether they are expected to prepare rules governing the employés in the use of these records, reports, etc.

Mr. D. D. Carothers (Baltimore & Ohio):—I suppose everyone remembers the Committee on Rules and Regulations, from the discussion we have had heretofore. I think from the progress made by our Committee, however, we would be willing to have the matter assigned to the other gentlemen. Undoubtedly it was the idea of the Board of Direction to have the rules made by a special committee, and not divided up among the different committees on the different subdivisions of the work.

Chairman McDonald:—The point has been made that this matter belongs to Committee No. 12. I confess I am not clear as to what the request of the chairman was—what rules he wanted to have prepared.

Mr. Wendt:—I think the question put is well answered by the statement that it applies to Committee on Uniform Rules and Organization.

Mr. E. K. Woodward (Wabash):—It seems to me there is a distinction between the rules as required by the Committee on Uniform Rules and Organization and the rules concerning which Mr. Wendt was speaking. I think he was speaking more particularly in regard to the instructions that are shown on page 24 of this report. These instructions refer to the labor accounts and similar matters, the classification and distribution of the various kinds of labor. I think Mr. Wendt had that in mind more than rules and regulations; in fact, it seems to me that these two subjects (they are practically two subjects) should be contained in one book, and of course that can only be done by the two committees working together.

Mr. Abbott:—I do not see how any forms that are presented to us will be of value unless those who have presented the forms describe how they are to be used, and that seems to me to be eminently the function of the committee that got up the forms for records and reports, and that is, as I understand it, all that the Committee wishes an expression of opinion upon. I do not see that that in any way conflicts with the Committee on Uniform Rules and Organization. You will notice they have four points to deal with—proper organization, that has nothing to do with accounts; code of titles, that has nothing to do with accounts; code of maintenance-of-way ethics; rules governing employes in the maintenance-of-way department. I think that rules prescribing the use of forms should certainly be the function of the present Committee.

Mr. Walker:—I emphatically approve of what Mr. Abbott has said. It seems to me the Committee is thoroughly familiar with the forms they are placing before us, and is eminently prepared to say how they should be used. I do not understand a motion to be necessary, but simply an expression of opinion, and my opinion is we should formulate a set of rules for using these forms.

Chairman McDonald:—On glancing over the instructions, every one of them appears to me to be within the province of this Committee, and if they want instructions on that point they should be given. It is probable, however, that the discussion we have had has been sufficient to indicate the opinion of the members, and the matter will be considered by the Board of Direction in issuing further instructions to the Committee.

Mr. Wendt:—Under the head of "Material Reports" the Committee recommends a blank to be used by section masters. The second conclusion of the Committee is as follows:

"2. MATERIAL REPORTS.—The Committee recommends the material blank for use of section masters, which blank is illustrated above. Said blank is small, yet very complete, and gives all necessary information to enable a complete check to be had on all material used.

"The blank should be used according to the same system as outlined for labor reports, viz.: the report being originally made up by the track foreman, forwarded to the supervisor, who checks the same and in turn forwards it to the office of the engineer, where all accounts are made up."

The Committee desires it to be understood that the members of the Committee were a unit in believing that this is a most excellent blank; one that met the condition laid down by the Board of Direction that it should give all necessary information to enable a complete checking up of all material used. The views of the members would be very valuable to the members of the Committee, but as the report has not been in the possession of the members long enough for them to become familiar with its contents, we have decided to say to the Association that we do not recommend this for adoption at this time. It is a suggestion showing the consensus of opinion of the members of the Committee.

Mr. Camp:—I know of one road that uses four classifications for rails. I would like to ask the Committee if they considered more than two classes of rails.

Mr. Wendt:—That is one criticism brought up against this blank. And the Committee takes this view of the matter, which will be found in the written part of the report: "The first column, 'account of material,' may be varied to suit the peculiar con-

ditions of a particular road in a particular part of the country." It would be manifestly impossible for the Committee to make out such a blank as would meet all the conditions throughout the country. You will find in the written discussion of the report that the Committee recommends the general outline of the blank, not the detail wording, as that can be made to suit special requirements. We think it fills the conditions and gives all information necessary to enable a complete check to be made of the material used.

Chairman McDonald:—Would it not be a good idea to amend that second clause, so as to state that the first column should be altered to suit the local requirements? Is there any further discussion of the second clause under the head of "Suggestions?"

Mr. Wendt:—The Committee would call your attention to the statement to the effect that "the first column, 'kind of material,' may be varied to suit the different requirements of the roads, but the Committee does believe that the ruling of the blanks and its headings are the best that can be designed." The Committee does not recommend this blank except as a general form.

One subject that the Committee intended to cover fully was the reports on bridges.

Our third conclusion states:

"3.—Complete records of bridges should be kept, which would show the information outlined above. However, this subject is so large and important as to require further study on the part of the Committee before recommending in detail any specific blank.

"It should be the aim of the Committee to continue its consideration of this subject for at least two more years, and to submit each year a progress report."

The illustration referred to in the text is a full-size blank reduced.

Chairman McDonald:—I would ask the chairman of the Committee what items of the first column are to be printed?

Mr. Wendt:—The idea of the Committee was to suggest a general form. Probably one-half of the description could be printed in the blank and the other half, or a larger proportion, if found necessary, would be left open to be filled as occasion necessitated.

Chairman McDonald:—This is an interesting subject, one with which many of us are confronted, and we would like to have a full discussion of it.

Mr. W. B. Poland (Baltimore & Ohio Southwestern):—What use is to be made of the first column of the blank shown, "Bridges without visible defects?" It seems to me if bridges have no visible defects they should not be mentioned, because many roads have a large number of structures, possibly 700 or 800 on a division, and if you mention all the bridges, whether they have defects or not, you make a cumbersome report, where you might probably have some information to give on possibly 40 or 50 bridges. This seems to me unnecessary.

Mr. Wendt:—The Committee was of the opinion that Mr. Poland would be in a better position to explain that blank than we are, as that is a Baltimore & Ohio blank. However, we think that bridges without defects should properly be reported on. It is one of the general principles that reports should be made at stated intervals. If no defects are visible, reports should be made just the same.

Mr. Poland:—Our department saw this blank the first time about two weeks ago. Since that time we have not had an opportunity of finding out how that column was intended to be used, or what the object was in reporting bridges that were all right. It does not seem to me necessary.

Chairman McDonald:—I think it is quite necessary to record the fact that a bridge has been inspected on a certain day.

Mr. Breckinridge:—Are two columns, "Action Under Traffic," necessary in the same blank?

Mr. Walker:—As an expression of my individual opinion, I should say it was. I have found in riding over a bridge on an engine that we could usually note a swing or anything that did not seem to be right. We can ride up to a bridge on a handcar, and the line of surface will appear to be perfect; but if we ride over the same bridge on an engine a defect may appear. I understand that the form is intended to be used for making note of these defects.

Chairman McDonald:—It would rather appear that the form is to be filled out by the man on the ground, and not on the engine.

Mr. Walker:—It might be that the man standing on the ground would discover the same thing as if he was on an engine.

Mr. H. G. Kelley (Minneapolis & St. Louis):—Would we not arrive at the same result by eliminating the words, "Deflection" and "Side Swing," and leave that column simply "Action Under Traffic?" Action under traffic is broad enough to take in any defects discovered by riding over the track.

Chairman McDonald:—That appears to be a pertinent suggestion.

Mr. Wendt:—The Committee will emphasize the fact that it had not time to make an exhaustive study of the questions involved, as we should have done. We confess to the convention the Committee has worked only six weeks, and in that time we could not gather data on this point sufficient to enable the Committee to make a recommendation; so that you will notice we have simply said: "Below will be found a report of an inspection of bridges. These reports are used by the supervisors of bridges and made up by them, after which they are forwarded to the office of the bridge engineer for his information." We hope that the future work of the Committee will include gathering of additional data on this subject, so that a general conclusion can be presented by the Committee.

Chairman McDonald:—We will take up conclusion 4:

"4.—It is believed that the system described for filing maps, plans, etc., above illustrated, is the best that is known at the present time. The card index system is excellent."

This is a subject in which we are all deeply interested, and we should have some interesting discussion on this point.

Mr. Wendt:—Attention is called to the illustrations showing a filing case placed in a vault connected with the engineering department drawing room; these illustrations to accompany the written description of the index system pertaining to records, reports or maps.

Chairman McDonald:—If there are no remarks to be made on conclusion No. 4, we will pass to conclusion No. 5:

"5.—The Committee makes no recommendation regarding form of contract for sidings to industries, because each railroad does business under conditions peculiar to itself. However, it

is believed by the Committee that the third contract above illustrated is the ideal contract to be used, especially where there is any doubt regarding the ability of the shipper to furnish traffic."

Mr. Wendt:—The illustrations in connection with conclusion 5 will be found in the report. This subject was taken up and considered in connection with a letter received from the Board of Direction after the subject had been brought to their attention by one of the Chief Engineers of a large railroad in this country.

Chairman McDonald:—This is a subject which comes close home to many of us—the question whether a new enterprise is going to justify putting in the sidetrack. If anyone has remarks to make on the subject, we will be glad to hear from him. If there are no remarks regarding conclusion No. 5, we will proceed to consider conclusion No. 6:

"6.—While the above system for filing correspondence will be found excellent, yet this subject is one on which the Committee makes no recommendation at this time, in view of the fact that this subject is worthy of a much more extended investigation than the Committee has been able to make."

The idea of this form of index is to cover all departments, as I understand it, to be used by each department.

Mr. Wendt:—It really covers all the requirements of a superintendent's office, who is in full charge of maintenance-of-way and transportation, and is well adapted to the office of division engineer, engineer of maintenance-of-way, assistant engineer or whatever title may be given to the position.

Chairman McDonald:—I notice such items as Station Agents and Clerks, Foreign Lines, Mail Service, Freight Traffic, Passenger Traffic, which lead me to believe that the blank was intended to be adopted by the entire system, from the President's office down. Is that correct?

Mr. Wendt:—It is adaptable to all conditions, but you will observe that where engineers are engaged in maintenance and construction work, carrying on a large amount of new work, they have correspondence bearing on almost every subject relating to the railroad business, and hence the system is adapted to all conditions.

Chairman McDonald:—Are there any further remarks on this conclusion 6? If not, we will proceed to conclusion 7:

"7.—Under the head of Accounts, including both labor and material accounts, the Committee is of the opinion that the classification and distribution of the same should be confined as closely as possible to the system of the Interstate Commerce Commission.

"Each heading may be further subdivided, but the fewer subheads the better."

Mr. Camp:—I believe the Committee will have to use a good many subheads under the Interstate Commerce distribution in order to make the accounts useful. I think the Interstate Commerce Commission's general classification is all right, but the distribution is almost useless for the purpose of getting an intelligible idea of the cost of the different kinds of maintenance-of-way work. Take, for instance, the track; the distribution of the track account is made up of the renewal of rails, which includes only the cost of the rails; the renewals of ties, which includes only the cost of the ties; and it includes most of the expense of maintaining track in the general account called "Repairs of Roadway." Under that general heading, "Repairs of Roadway," is included all track work. You cannot find the cost of tamping or surfacing the track, the cost of shimming or any of the important items.

I think this account, "Repairs of Roadway," should be split up, so that one could get at the cost of some of the most important items of track maintenance work. A well-informed railway official, who read a paper before one of the railway clubs not long ago, remarked upon the dearth of general information to be had on the cost of raising and tamping old track to maintain it in surface. Railway men, for a good many years, have been discussing in their associations the relative merits of broken stone and gravel for ballast. The gist of most of this discussion is that one man thinks, from general observation and experience, that broken stone ballast holds the track to surface better than gravel, and that, notwithstanding its higher first cost and the fact that it is a more expensive ballast to work in, it is, in the end, the cheapest material on which to maintain track surface. Another man, in some instances from the same road, where the traffic conditions are the same or similar, from his observation and experience thinks the reverse. Average figures of the relative expense of maintaining track surface with the two kinds of ballast, under similar train tonnage, would practically settle the

question; but rarely, if ever, are such figures offered as argument, simply because they are not to be had without going behind the accounts and making a special search through a great mass of monthly reports.

There are but few roads where a separate account is made of this work, and yet it constitutes a large percentage of the cost of maintaining track. The Committee on Ballasting, in its report to this Association last year (page 60 of the Proceedings for 1901), estimates that 40 per cent of the pay-roll of trackmen goes for lining and surfacing. The only way to get an estimate of the cost of this work is to go over the labor reports of the section foreman on file at the office of the roadmaster or supervisor. For their own information some division maintenance-of-way officers do this at the end of each year, but the general accounts, made primarily for reporting to the Interstate Commerce Commission, contain none of these items. Even the cost of renewing rails or of renewing ties (including the expense for labor) cannot be found in the classification of the Interstate Commerce Commission. A further subdivision or a more detailed distribution of maintenance-of-way expenses would not impair the adaptability of the accounts to the classification of this commission.

Another defect in the Interstate Commerce Commission's classification of maintenance-of-way accounts, at least so far as the purposes of this Association are directed, is that the expense of track and bridge maintenance are to some extent mixed. For instance, item 4, under the heading "Maintenance-of-Way and Structures," covers "Repairs and Renewals of Bridges and Culverts." The renewing of culverts on some roads is in charge of the bridge department, while on others it is in charge of the track department. In order to make a satisfactory division of maintenance-of-way expense, this account should be separated into distinct items for bridges and for culverts.

Chairman McDonald:—I understand you to suggest the propriety of taking the Interstate Commerce Commission's headings and splitting them up into useful subdivisions?

Mr. Camp:—Yes; it will not be departing from the Interstate Commerce Commission's classification at all. The general headings will still conform to the outline of the Interstate Commerce Commission's classification. It will simply be splitting

up that classification for the benefit of the railway men who need the details of these general expense accounts.

Mr. Abbott:—I think we are getting pretty close to the auditing department, and on many roads we might run up against the auditing department, and that would make two lines of work necessary, if we divide it according to what we need for our own information and what was required by the auditing department for their accounts. And that by coöperation between the auditing department and the engineering department, or maintenance department, it would be possible to arrive at some series of subheads that would be useful to both the accounting department and our own for determining the costs of the various subheads.

Chairman McDonald:—We will now take up conclusion No. 8.

Mr. Wendt:—Conclusion No. 8 is as follows: "As a general proposition, the Committee submits the above as a progress report."

The Committee would say that an expression of opinion would be desirable in regard to this form of agreement for side-tracks to industries. It was taken up at the instance of the Board of Direction. The Committee feels that the convention has not read the points presented, and it is not ready to ask at this time for an expression of opinion. But it seems to me, however, that the Board of Direction should communicate in the next sixty days with the future Committee as to what further work on this same subject they desire shall be done. Further than this, it also seems to the Committee that the Board of Direction, in view of the fact that the convention has not been able to study the report and instruct the Committee at this time, that the Committee would be pleased to have the Board of Direction indicate, if it chooses, what subjects should be studied during the next year. It is obvious that the lesser number of subjects the better; probably one only should be considered during the twelve months; at most two subjects. It is apparent from a casual examination of the report that almost any of the subjects treated (and there are at least seven general subjects considered, and it might be said there are about ten) would be sufficient for one year's work. It is hoped by the Committee that some expression, either on the

part of the convention or on the part of the Board of Direction, will be given during the next sixty days.

Chairman McDonald:—I think the Board fully recognizes the importance of confining the committees to narrow channels, and I think it is their intention to do so from now on. This remark applies to all of the reports.

(On motion, the report of the Committee was adopted as a whole.)

Chairman McDonald:—The Committees on Uniform Rules, Organization, etc., and on Water Service have not been able to get together and formulate reports, and none have been received. The report of the tellers will now be announced.

Secretary Fritch:—The tellers appointed to canvass the votes cast for officers of the Association for the current year report as follows:

*President.*

George W. Kittredge.....	239
A. W. Johnston.....	I
E. A. Handy.....	I
C. S. Sims.....	I
Thomas Rodd .....	I

*Second Vice-President.*

Hunter McDonald .....	242
W. J. Harahan.....	I

*Secretary.*

L. C. Fritch.....	243
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*Treasurer.*

W. S. Dawley.....	243
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*Two Directors.*

F. H. McGuigan.....	243
A. W. Johnston.....	240
H. Fernstrom .....	I
E. A. Handy.....	I
W. G. Van Vleck.....	I

Chairman McDonald:—Gentlemen, you have heard the report of the Committee. The gentlemen receiving the highest number of votes have been elected as officers of the Association for the ensuing year.

Mr. E. E. R. Tratman:—Mr. Chairman, in view of the pleasant way in which arrangements have been made for the convention affairs and the convenience of members in attendance, I would move the following resolution:

“Resolved, That a vote of thanks be extended to the Committee of Arrangements for the excellent manner in which it has performed its duties, both in regard to the technical and social features of the convention.”

(The resolution was unanimously adopted.)

Mr. W. B. Poland (Baltimore & Ohio Southwestern):—If new business is in order, I would say that in the report of the Committee on Track we ask that a special committee be appointed to consider the subject of widening of gauge on curves. That is new ground, which it is expected that the Committee on Track is to cover, but it is such a large subject and requires such special investigation that it seemed to our Committee that it should be considered by a special committee, for the reason that it is a subject that involves motive power. It seemed to us that it would be better to have it considered by a joint committee of the members of the Master Mechanics' Association in connection with a committee of our own Association. It is a matter which depends upon the flange wear and the number of flanges and location of flanges on the drivers of the engine, so that I would like to suggest that a special committee be appointed to consider that subject. We would also like the committee to consider the subject of “What is Gauge?” meaning by that to consider what is gauge in the case of a worn rail on a curve. We are all familiar with the way in which the ball wears on curve rails. It is worn always on an incline. Now, if you have a long finger on the gauge, you will get a shorter distance between the rails than if you have a short finger, which will not go so far down the incline. It is a matter which our section foremen are not well posted on. They do not know what gauge is on a curve; their ideas are different. And in talking to engineers, even, I find their ideas are quite different. It is also a matter that depends a good

deal on the flanges of the wheels and should be considered jointly, I think, with the Master Mechanics' Association. If it is proper, I will put that in the form of a motion.

Chairman McDonald:—We would like to hear from the members as to the wisdom of appointing this special committee in addition to the Track Committee.

Mr. D. D. Carothers (Baltimore & Ohio):—It seems to me that in the work of special committees is where we are going to get the greatest results in the work of this Association, and it is surely a very pertinent suggestion that this committee should be appointed. This question has been up before the associations of the country for a good many years—the American Railway Association, the Master Car Builders' Association—and there has never been anything done to harmonize the different views of the different departments. I think it is a very important matter that this Association should appoint a committee to act in conjunction with the Master Car Builders' Association or the Master Mechanics' Association—perhaps the latter association, as they are more interested in the question, or it might be well to have a conference with both associations.

Chairman McDonald:—Would it not answer the purpose to have the Committee on Track make that a special consideration for next year's work?

Mr. Carothers:—I believe the question is one that is too large to impose on a committee that has as much to do as the Track Committee. It warrants the appointment of a special committee that will give it proper attention. It will probably require a great deal of correspondence and a joint meeting of the two committees.

Mr. E. E. R. Tratman (Engineering News):—I think, two years ago, the Master Mechanics' Association had a special committee on this subject, which made careful investigations and presented its report at the convention of 1900. From the locomotive point of view, they went into it carefully, making tests on the Lehigh Valley Railroad. On the question of flanged wheels, you have probably all heard of the new decapod freight engines for the Atchison, Topeka & Santa Fe Railway. These are not all alike, but some have all the drivers flanged and some have a blind pair of drivers on the middle pair of wheels. I

would suggest that this matter be referred to a special committee for consideration.

Chairman McDonald :—I hardly think the members are familiar with the requirements of the Constitution relating to special committees. I will read it :

“Section 6. Special committees to examine into and report upon any subject connected with the purposes of this Association may be appointed in the following manner: A resolution to appoint such committee, setting forth its objects and the number of its members, may be presented by letter at any time to the Secretary of the Association, if signed by ten active members, and shall be referred by him to the Board of Direction, which, if it sees fit, may appoint such committee. If the Board of Direction should not deem it expedient to appoint such committee, the members requesting the appointment of such committee shall be notified, and the matter will then be referred to the Association at its next annual meeting and decided upon by ballot. If two-thirds of the members present vote in favor of such committee, it shall be appointed by the President.”

I think the discussion has served a useful purpose to get the sentiment of the members present as to whether we need that committee or not, and the appointment of the committee will be left to the usual methods.

Mr. H. G. Kelley (Minneapolis & St. Louis) :—I desire to bring a subject to the attention of the meeting. I really am at a loss to say what committee should properly consider it, as it involves so many features. The subject was contained, if I recall, in the list of requests for information sent out by the Committee on Iron and Steel Structures. I refer to the allowable pressure upon wheels. I do not know whether any of the various companies or any of the members present keep a special record of the causes of derailments, but I have endeavored to keep such a record for some time, and for some eighteen months, excluding small derailments in yards, half-thrown switches and like work of that kind, I find the greatest number of derailments to arise from broken flanges. I think if the members will look back over the last twenty years they will find that cast-iron wheels have been strengthened in the body and in the tread, to carry the new loads, but during all this time no change has been made, nor can be made, in the flanges. The flange of the ordinary cast-iron

wheel to-day is almost what it was when the cars carried only 20,000 pounds. Either the cast-iron flange of that day was too strong, or it is too weak now, and we cannot increase its base, because all of our frogs, guardrails and clearances of every kind are based on this particular form of flange. I believe if the members, during the year, will keep a record they will find that the derailments and accidents due to broken flanges are becoming extraordinary, and nearly all of them occur under the highly loaded cars, 80,000 to 100,000 pounds, and if the members will take a diagram of the present flange, and then draw on it the amount of wear that is allowable, under the Master Car Builders' rules, they will be astonished at the small amount of metal that is left in the wheel to withstand all the shocks that it gets in going over switches and frogs; but I do not know that we can improve this condition so long as we use cast-iron wheels and continue to load our cars to the extent we are doing to-day.

Chairman McDonald:—The subject is one that belongs to the Master Car Builders' Association and not to this organization, unless the Master Car Builders should undertake to put the responsibility for the failure on the maintenance department, as they sometimes do. I hardly think that is a matter for consideration by this organization alone.

Mr. J. A. Atwood (Pittsburg & Lake Erie:)—The trouble can be overcome, possibly, by the use of ball center and side bearings for your cars. We have had a gondola car on our road (Pittsburg & Lake Erie) for three years or more, and it was found upon examination that the wear on the flanges of the wheels was practically nothing during that three years of service.

(On motion, the meeting adjourned.)

## APPENDIX

**OFFICERS OF PRELIMINARY ORGANIZATION.**  
**1898-1899.**

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*Chairman.*

A. TORREY, Michigan Central Railroad, Detroit, Mich.

*Secretary.*

L. C. FRITCH, Baltimore & Ohio Southwestern Railroad, Washington,  
Ind.

*Committee on Constitution and By-Laws.*

J. F. WALLACE, Illinois Central Railroad, Chicago, Ill., Chairman.

THOS. RODD, Pennsylvania Lines, Pittsburg, Pa.

W. G. CURTIS, Southern Pacific Company, San Francisco, Cal.

C. H. HUDSON, Southern Railway, Washington, D. C.

P. ALEX. PETERSON, Canadian Pacific Railway, Montreal, Can.

## OFFICERS OF PERMANENT ORGANIZATION.

1899-1900.

---

### *President.*

J. F. WALLACE, Illinois Central Railroad, Chicago, Ill.

### *First Vice-President.*

P. ALEX. PETERSON, Canadian Pacific Railway, Montreal, Can.

### *Second Vice-President.*

W. G. CURTIS, Southern Pacific Company, San Francisco, Cal.

### *Secretary.*

L. C. FRITCH, Baltimore & Ohio Southwestern Railroad, Washington, Ind.

### *Treasurer.*

W. S. DAWLEY, Chicago & Eastern Illinois Railroad, Chicago, Ill.

### *Directors.*

A. TORREY, Michigan Central Railroad, Detroit, Mich.

THOS. RODD, Pennsylvania Lines, Pittsburg, Pa.

F. H. MCGUIGAN, Grand Trunk Railway, Montreal, Canada.

W. K. MCFARLIN, Delaware, Lackawanna & Western Railroad, Hoboken, N. J.

HUNTER McDONALD, Nashville, Chattanooga & St. Louis Railway, Nashville, Tenn.

D. J. WHITTEMORE, Chicago, Milwaukee & St. Paul Railway, Chicago, Ill.

## OFFICERS 1900-1901.

---

### *President.*

J. F. WALLACE, Illinois Central Railroad, Chicago, Ill.

### *First Vice-President.*

P. ALEX. PETERSON, Canadian Pacific Railway, Montreal, Can.

### *Second Vice-President.*

HUNTER McDONALD, Nashville, Chattanooga & St. Louis Railway, Nashville, Tenn.

### *Secretary.*

L. C. FRITCH, Baltimore & Ohio Southwestern Railroad, Washington, Ind.

### *Treasurer.*

W. S. DAWLEY, Chicago & Eastern Illinois Railroad, Chicago, Ill.

### *Directors.*

A. TORREY, Michigan Central Railroad, Detroit, Mich.

THOS. RODD, Pennsylvania Lines, Pittsburg, Pa.

F. H. MCGUIGAN, Grand Trunk Railway, Montreal, Canada.

W. K. MCFARLIN, Delaware, Lackawanna & Western Railroad, Hoboken, N. J.

J. KRUTTSCHNITT, Southern Pacific Company, San Francisco, Cal.

D. J. WHITTEMORE, Chicago, Milwaukee & St. Paul Railway, Chicago, Ill.

## OFFICERS 1901-1902.

---

### *President.*

GEORGE W. KITTREDGE, Cleveland, Cincinnati, Chicago & St. Louis Railway, Cincinnati, Ohio.

### *First Vice-President.*

HUNTER McDONALD, Nashville, Chattanooga & St. Louis Railway, Nashville, Tenn.

### *Second Vice-President.*

A. W. SULLIVAN, Illinois Central Railroad, Chicago, Ill.

### *Secretary.*

L. C. FRITCH, Baltimore & Ohio Southwestern Railroad, Washington, Ind.

### *Treasurer.*

W. S. DAWLEY, Chicago & Eastern Illinois Railroad, Chicago, Ill.

### *Directors.*

A. TORREY, Michigan Central Railroad, Detroit, Mich.

THOS. RODD, Pennsylvania Lines, Pittsburg, Pa.

F. H. MCGUIGAN, Grand Trunk Railway, Montreal, Canada.

H. F. BALDWIN, Chicago & Alton Railway, Chicago, Ill.

T. F. WHITTELSEY, Toledo & Ohio Central Railway, Toledo, O.

J. KRUTTSCHNITT, Southern Pacific Company, San Francisco, Cal.

## OFFICERS 1902-1903.

---

### *President.*

GEORGE W. KITTREDGE, Cleveland, Cincinnati, Chicago and St. Louis Railway, Cincinnati, Ohio.

### *First Vice-President.*

A. W. SULLIVAN, Illinois Central Railroad, Chicago, Ill.

### *Second Vice-President.*

HUNTER McDONALD, Nashville, Chattanooga & St. Louis Railway, Nashville, Tenn.

### *Secretary.*

L. C. FRITCH, Baltimore & Ohio Southwestern Railroad, Cincinnati, Ohio. (Office, 1562 Monadnock Block, Chicago, Ill.)

### *Treasurer.*

W. S. DAWLEY, Chicago & Eastern Illinois Railroad, Chicago, Ill.

### DIRECTORS.

#### *One Year.*

A. TORREY, Michigan Central Railroad, Detroit, Mich.

THOS. RODD, Pennsylvania Lines West of Pittsburg, Pittsburg, Pa.

#### *Two Years.*

J. KRUTTSCHNITT, Southern Pacific Company, San Francisco, Cal.

T. F. WHITTELEY, Toledo Terminal Railway, Toledo, Ohio.

#### *Three Years.*

F. H. MCGUIGAN, Grand Trunk Railway, Montreal, Canada.

A. W. JOHNSTON, New York, Chicago & St. Louis Railway, Cleveland, Ohio.

## LIST OF MEMBERS.

---

### A

- 384. ABBOTT, F. E. (Rail),  
Civil Engineer—Inspecting Engineer Illinois Steel Company,  
The Rookery, Chicago, Ill.
- 369. ABBOTT, J. H. (Vice-Chairman Uniform Rules, Organization, etc.),  
Division Engineer Baltimore & Ohio Railroad,  
Cleveland, Ohio.
- 400. ACKERT, C. H.,  
General Manager Southern Railway,  
Washington, D. C.
- 176. ADDISON, C. L. (Signaling and Interlocking),  
Superintendent of Transportation Long Island Railroad,  
Long Island City, N. Y.
- 237. AISHTON, R. H. (Uniform Rules, Organization, etc.),  
Assistant General Manager Chicago & Northwestern Rail-  
way, 22 Fifth Avenue, Chicago, Ill.
- 164. ALFRED, F. H. (Signs, Fences, Crossings, etc.),  
Assistant Engineer Pere Marquette Railroad,  
Saginaw, Mich.
- 440. ALLEN, ANDREWS,  
Engineer Wisconsin Bridge Company,  
1022 Monadnock Block, Chicago, Ill.
- 298. ALLEN, C. FRANK (Roadway),  
Professor of Railroad Engineering, Massachusetts Institute  
of Technology, Boston, Mass.
- 394. ANDROS, F. W.,  
Chief Engineer Chihuahua & Pacific Railway,  
Chihuahua, Mexico.
- 55. ANTHONY, F. D.,  
Chief Engineer Quebec Southern Railway,  
Sorel, Quebec.
- 39. ARCHER, WM. (Ties),  
Principal Assistant Engineer Baltimore & Ohio South-west-  
ern Railroad, Cincinnati, Ohio.
- 334. ASHEY, E. B.,  
Engineer Maintenance-of-Way Lehigh Valley Railroad,  
South Bethlehem, Pa.

129. ATWOOD, J. A. (Yards and Terminals),  
Chief Engineer Pittsburg & Lake Erie Railroad,  
Pittsburg, Pa.

## B

135. BAILEY, D. S.,  
Superintendent Illinois Central Railroad,  
Clinton, Ill.
56. BAKER, H.,  
Superintendent Southern Railway,  
Charlotte, N. C.
447. BALDWIN, A. S. (Chairman Committee on Signs, Fences, Crossings),  
Principal Assistant Engineer Illinois Central Railroad,  
Chicago, Ill.
73. BALDWIN, HADLEY (Roadway),  
Engineer Maintenance-of-Way Cleveland, Cincinnati, Chi-  
cago & St. Louis Railway, Indianapolis, Ind.
136. BALDWIN, H. F. (Buildings),  
Chief Engineer Chicago & Alton Railway,  
Chicago, Ill.
382. BALDWIN, L. W.,  
Roadmaster Yazoo & Mississippi Valley Railroad,  
Memphis, Tenn.
323. BARNARD, J. A. (Chairman Uniform Rules, Organization, etc.),  
General Manager Peoria & Eastern Railway (C. C. C. &  
St. L. Ry., Lessee), Indianapolis, Ind.
90. BARNARD, R. C. (Roadway),  
Superintendent Pennsylvania Lines West,  
Cambridge, Ohio.
121. BARRINGTON, EDWARD,  
Resident Engineer Vera Cruz & Pacific Railway,  
Tierra Blanca, Mexico.
424. BASSETT, W. I.,  
Assistant Engineer Vancouver, Victoria & Eastern Railroad,  
Grand Forks, B. C.
119. BATES, ONWARD,  
Consulting Engineer,  
Manhattan Building, Chicago, Ill.
275. BEAUMAN, L.,  
Assistant Engineer Gulf, Colorado & Santa Fe Railway,  
Cleburne, Texas.
239. BELL, ROBERT (Vice-Chairman Committee on Ties),  
Superintendent Pennsylvania Railroad,  
Buffalo, N. Y.

213. **BENT, SHELDON T.**,  
General Superintendent Vera Cruz & Pacific Railway,  
Orizaba, Mexico.
201. **BERG, WALTER G.**,  
Chief Engineer Lehigh Valley Railroad,  
New York, N. Y.
179. **BERRY, J. B. (Ties)**,  
Chief Engineer Union Pacific Railroad,  
Omaha, Neb.
238. **BESLER, W. G. (Vice-Chairman Com. on Yards and Terminals)**,  
General Manager Central Railroad of New Jersey,  
New York, N. Y.
223. **BIDWELL, GEO. F.**,  
General Manager Fremont, Elkhorn & Missouri Valley Rail-  
road, Omaha, Neb.
47. **BISBEE, F. M.**,  
Chief Engineer Tennessee Construction Company,  
Nashville, Tenn.
227. **BISSELL, F. E.**,  
First Assistant Engineer Lake Shore & Michigan Southern,  
Cleveland, Ohio.
314. **BLAIKLOCK, M. S. (Yards and Terminals)**,  
Superintendent Grand Trunk Railway,  
Montreal, Canada.
385. **BLOOM, J. G.**,  
Division Engineer Baltimore & Ohio Railroad,  
New Castle, Pa.
240. **BLUE, C. F.**,  
Roadmaster Mobile & Ohio Railroad,  
Cairo, Ill.
390. **BODY, JOHN B.**,  
Director National Railway of Tehuantepec,  
City of Mexico, Mexico.
452. **BOGUE, V. G.**,  
Civil Engineer,  
66 Broadway, New York, N. Y.
191. **BONNYMAN, A.**,  
Superintendent Atlantic & Birmingham Railroad,  
Waycross, Ga.
128. **BOOTS, E. W.**,  
Assistant Engineer Pittsburg & Lake Erie Railroad,  
McKeesport, Pa.
324. **BOUSCAREN, GUSTAVE (Rail)**,  
Consulting Engineer—Chief Engineer Commissioners of  
Water Works, City Hall, Cincinnati, Ohio.

197. **BRADFORD, H. P.,**  
General Manager Cia. de Ferrocarriles del D. F. de Mexico,  
City of Mexico, Mexico.
219. **BRECKINRIDGE, W. L. (Vice-Chairman Committee on Masonry),**  
Chief Engineer Chicago, Burlington & Quincy Railroad,  
209 Adams Street, Chicago, Ill.
432. **BRISTOL, G. F.,**  
Assistant Engineer P. M. R. R.,  
Grand Rapids, Mich.
367. **BROWN, E. C. (Masonry),**  
Engineer Maintenance-of-Way Union Railway,  
Port Perry, Pa.
410. **BRUNNER, JOHN (Iron and Steel Structures),**  
Assistant General Superintendent, North Works, Illinois  
Steel Company, Chicago, Ill.
217. **BRYAN, C. E.,**  
Division Engineer Baltimore & Ohio Railroad,  
Parkersburg, W. Va.
280. **BRYAN, F. A.,**  
Secretary and General Manager South Bend Electric Co.,  
South Bend, Ind.
241. **BUCK, A. L.,**  
Construction Department Canadian Pacific Railway,  
Winnipeg, Man.
317. **BULLIS, S. S.,**  
President Buffalo, Attica & Arcade Railroad,  
Olean, N. Y.
152. **BURWELL, BLAIR, JR.,**  
Civil Engineer,  
Jacksonville, Fla.
89. **BYERS, M. L.,**  
Engineer Maintenance-of-Way Baltimore & Ohio Railroad,  
Baltimore, Md.

## C

242. **CAMP, W. M. (Vice-Chairman Committee on Track),**  
Editor Railway and Engineering Review,  
1305 Manhattan Building, Chicago, Ill.
25. **CAROTHERS, D. D. (Uniform Rules, Organization, etc.),**  
Superintendent Baltimore & Ohio Railroad,  
Chicago, Ill.
148. **CARPENTER, M. J.,**  
President Chicago & Eastern Illinois Railroad,  
355 Dearborn Street, Chicago, Ill.

422. CASSELL, J. F.,  
Chief Engineer Elgin, Joliet & Eastern Railroad,  
Joliet, Ill.
96. CHANUTE, O. (Ties),  
Consulting Engineer,  
413 East Huron Street, Chicago, Ill.
289. CHASE, WENDELL N.,  
Consulting Engineer Pacific Coast Company,  
526 Burke Building, Seattle, Wash.
77. CHEYNEY, C. S.,  
Assistant Engineer New York Central & Hudson River  
Railroad, Buffalo, N. Y.
274. CHRISTY, J. C.,  
Assistant Engineer Gulf, Colorado & Santa Fe Railway,  
Temple, Tex.
29. CHURCHILL, C. S. (Uniform Rules, Organization, etc.),  
Engineer Maintenance-of-Way Norfolk & Western Railway,  
Roanoke, Va.
291. CLARK, J. M.,  
Superintendent and Chief Engineer Boise, Nampa & Owyhee  
and Idaho Northern Railroads, Nampa, Idaho.
328. CLARKE, C. S. (Uniform Rules, Organization, etc.),  
General Manager Mobile & Ohio Railroad,  
St. Louis, Mo.
196. CLEVELAND, G. C.,  
Assistant to Chief Engineer Lake Erie & Western Railway,  
Indianapolis, Ind.
388. COATES, F. R. (Track),  
Chief Engineer Chicago Great Western Railway,  
St. Paul, Minn.
438. COGSWELL, C. P., JR.,  
Division Engineer Chicago Great Western Railway,  
Red Wing, Minn.
457. COLLINS, E. M.,  
General Superintendent Missouri, Kansas & Texas Railway,  
408 Wainwright Building, St. Louis, Mo.
389. COLPITTS, W. W.,  
Assistant Engineer Kansas City, Mexico & Orient Railway, .  
Kansas City, Mo.
450. CONDON, W. E.,  
Engineer El Paso-Rock Island Route,  
Alamogordo, N. M.
243. CONDRON, T. L. (Iron and Steel Structures),  
Consulting Engineer,  
1750 Monadnock Block, Chicago, Ill.

94. COOLEY, M. W. (Masonry),  
Manager National Contracting Company,  
70 Kilby Street, Boston, Mass.
165. COTTER, WILLIAM,  
General Superintendent St. Louis, Iron Mountain & South-  
ern Railway, St. Louis, Mo.
177. COTTINGHAM, I. A.,  
Division Engineer Southern Pacific Company,  
El Paso, Texas.
303. COWAN, H. W. (Buildings),  
Chief Engineer Colorado & Southern Railway,  
Denver, Colo.
202. COWPER, J. W.,  
Westinghouse Electric Works,  
Trafford Park, Manchester, England.
23. COX, J. B. (Yards and Terminals),  
Chief Engineer Chicago Junction Railway,  
180 Exchange Building, U. S. Y., Chicago, Ill.
376. CRANDALL, C. L. (Iron and Steel Structures),  
Professor of Railroad Engineering, Cornell University,  
Ithaca, N. Y.
46. CROCKER, GEO.,  
Chief Engineer Detroit Southern Railway,  
Springfield, Ohio.
110. CULVERWELL, R. S.,  
Resident Engineer Southern Pacific Company,  
San Francisco, Cal.
435. CUMMINS, T. R.,  
Roadmaster Illinois Central Railroad,  
Carbondale, Ill.
445. CURTIS, L. G.,  
Assistant Division Engineer Baltimore & Ohio Railroad,  
Garrett, Ind.
370. CURTIS, W. W. (Ties),  
Consulting Engineer,  
Marquette Building, Chicago, Ill.
150. CUSHING, E. B. (Chairman Committee on Ties),  
Engineer Maintenance-of-Way Atlantic System Southern  
Pacific Company, Houston, Texas.
16. CUSHING, W. C. (Vice-Chair. Com. on Signaling and Interlocking),  
Superintendent Pennsylvania Lines West,  
Pittsburg, Pa.

## D

59. DAGRON, L. L.,  
Roadmaster Illinois Central Railroad,  
New Orleans, La.
295. DAILEY, JOHN C.,  
Superintendent Illinois Central Railroad,  
Louisville, Ky.
22. DARLING, W. L.,  
Chief Engineer Northern Pacific Railway,  
St. Paul, Minn.
30. DAUCHY, W. E.,  
Chief Engineer Chicago, Rock Island & Pacific Railway,  
Chicago, Ill.
343. DAVIDSON, A. J.,  
General Superintendent St. Louis & San Francisco Railroad,  
St. Louis, Mo.
244. DAVIS, CHARLES HENRY,  
Consulting Engineer,  
25 Broad Street, New York, N. Y.
247. DAVIS, GARRETT (Track),  
Assistant Chief Engineer Burlington, Cedar Rapids &  
Northern Railway, Cedar Rapids, Iowa.
34. DAVIS, J. R. W.,  
Engineer Maintenance-of-Way Erie Railroad,  
Jersey City, N. J.
351. DAVISSON, W. H. (Water Service),  
Assistant Chief Engineer Chicago, Rock Island & Pacific  
Railway, Chicago, Ill.
211. DAWLEY, E. P. (Yards and Terminals),  
Division Engineer New York, New Haven & Hartford Rail-  
road, Boston, Mass.
28. DAWLEY, W. S. (Treasurer),  
Chief Engineer Chicago & Eastern Illinois Railroad,  
355 Dearborn Street, Chicago, Ill.
381. DAY, R. W.,  
Division Engineer Del., Lack. & Western,  
Hoboken, N. J.
380. DEAN, JOHN (Masonry),  
Consulting Engineer,  
St. Louis, Mo.
368. DEIMLING, J. F.,  
Chief Engineer Lake Superior and Ishpeming Railway,  
Marquette, Mich.
358. DELANO, F. A.,  
General Manager Chicago, Burlington & Quincy Railroad,  
Chicago, Ill.

398. DENNIS, A. C. (Roadway),  
Div. Eng. Con. Dept. Canadian Pacific Railway,  
Montreal, Canada.
245. DICKINSON, E. (Uniform Rules, Organization, etc.),  
General Manager Union Pacific Railroad,  
Omaha, Neb.
454. DICKSON, B. F. (Buildings),  
Engineer Maintenance-of-Way Kansas City Southern Rail-  
way, Kansas City, Mo.
43. DIDIER, PAUL,  
Assistant Chief Engineer Pittsburg & Western Railroad,  
Allegheny, Pa.
332. DILL, H. R.,  
Assistant Superintendent Louisville Division Illinois Cen-  
tral Railroad, Evansville, Ind.
326. DIXON, J. M.,  
Assistant Engineer Northern Pacific Railway,  
St. Paul, Minn.
31. DOUGHERTY, C. (Vice-Chairman Committee on Roadway),  
Superintendent Illinois Central Railroad,  
Clinton, Ill.
19. DOUGLAS, B. (Vice-Chairman Com. on Iron and Steel Structures),  
Bridge Engineer Michigan Central Railroad,  
Detroit, Mich.
80. DOWNS, L. A.,  
Roadmaster Illinois Central Railroad,  
Louisville, Ky.
437. DOYLE, JOHN (Track),  
Superintendent of Tracks Pere Marquette Railroad,  
Detroit, Mich.
154. DRAKE, W. A.,  
General Superintendent and Chief Engineer Santa Fe, Pres-  
cott & Phoenix and Prescott & Eastern Railroads,  
Prescott, Ariz.
109. DRAPER, H. C.,  
6606 Perry Avenue, Chicago, Ill.
246. DREW, G. E.,  
Chief Engineer South Haven & Eastern Railway,  
Three Oaks, Mich.
353. DUN, JAMES,  
Chief Engineer Atchison, Topeka & Santa Fe Railway  
System, Great Northern Building, Chicago, Ill.
305. DUNN, D. B. (Wooden Bridges and Trestles),  
Chief Engineer Macon, Dublin & Savannah Railroad,  
Macon, Ga.

127. DUNN, O. M.,  
Assistant General Superintendent Illinois Central Railroad,  
New Orleans, La.
225. DUNN, SEELY,  
Vice-President and General Manager Blackwell, Enid &  
Southwestern Railroad, Vernon, Texas.

## E

141. EGAN, A. H.,  
Assistant Superintendent Illinois Central Railroad,  
Chicago, Ill.
312. ELLIOTT, HOWARD,  
Second Vice-President Chicago, Burlington & Quincy Rail-  
road, 603 Globe Democrat Bldg., St. Louis, Mo.
297. EMMERT, J. H.,  
Assistant to President Santa Fe, Prescott & Phoenix Rail-  
way, Prescott, Ariz.
402. ERICSON, E. G. (Vice-Chairman Committee on Signs, Fences, etc.),  
Assistant Engineer Pennsylvania Lines,  
Pittsburg, Pa.
175. EWING, C. H. (Signs, Fences, Crossings, etc.),  
Chief Engineer Central New England Railway,  
Hartford, Conn.

## F

248. FAITHORN, J. N.,  
President and General Manager Chicago Terminal Transfer  
Railroad, Grand Central Passenger Station,  
Chicago, Ill.
44. FELT, C. F. W. (Masonry),  
Chief Engineer Gulf, Colorado & Santa Fe Railway,  
Galveston, Texas.
167. FELTON, S. M. (Rail),  
President Chicago & Alton Railway,  
Monadnock Block, Chicago, Ill.
27. FENDALL, B. T.,  
City Engineer,  
Baltimore, Md.
149. FERNSTROM, H.,  
Assistant Chief Engineer New York Central & Hudson  
River Railroad, New York, N. Y.
309. FERRIS, H. C.,  
Superintendent Union Pacific Railroad,  
Omaha, Neb.

373. **FIERO, A. W.,**  
Inspecting Engineer,  
The Rookery, Chicago, Ill.
199. **FISHER, S. B. (Ballasting),**  
Chief Engineer Missouri, Kansas & Texas Railway,  
St. Louis, Mo.
132. **FITZGERALD, THOMAS,**  
Resident Engineer and Assistant Superintendent Southern  
Pacific Company, Ogden, Utah.
65. **FITZHUGH, E. H.,**  
Vice-President and General Manager Central Vermont  
Railway, St. Albans, Vt.
322. **FLANDERS, J. B. (Signs, Fences, Crossings, etc.),**  
General Superintendent Cincinnati Northern Railroad,  
Toledo, Ohio.
407. **FLEMING, H. G.,**  
General Superintendent L. R. & H. S. W. Railroad,  
Hot Springs, Ark.
194. **FLOESCH, J. M.,**  
Chief Engineer Buffalo, Rochester & Pittsburg Railroad,  
Rochester, N. Y.
406. **FORD, EDWARD,**  
Superintendent Alabama & Vicksburg Railroad,  
Vicksburg, Miss.
134. **FRAZIER, J. L. (Vice-Chairman Committee on Water Service),**  
General Superintendent T., St. L. & W. Railway,  
Frankfort, Ind.
181. **FRAZIER, T. J.,**  
Assistant Superintendent Maintenance-of-Way Baltimore &  
Ohio Railroad, Zanesville, Ohio.
224. **FREY, J. J.,**  
President Trans-Alaskan Railway,  
Seattle, Wash.
2. **FRITCH, L. C. (Secretary),**  
Superintendent Baltimore & Ohio Southwestern Railroad,  
Cincinnati, Ohio.

## G

444. **GALVIN, P.,**  
Roadmaster Illinois Central Railroad,  
Louisville, Ky.
365. **GARDNER, G. W.,**  
Roadmaster St. Louis, Iron Mountain & Southern Rail-  
way, Newport, Ark.

316. **GARDNER, W. A.,**  
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144. **GARRETT, W. A.** (Uniform Rules, Organization, etc.).  
General Superintendent Philadelphia & Reading Railway,  
Reading, Pa.
113. **GILLEAS, B. J.,**  
Superintendent Illinois Central Railroad,  
Cherokee, Iowa.
115. **GILLEAS, H.,**  
Roadmaster Illinois Central Railroad,  
Cherokee, Iowa.
198. **GOODALE, L. F.** (Records, Reports and Accounts),  
Chief Engineer Burlington's Missouri Lines,  
St. Louis, Mo.
329. **GOODE, J. V.,**  
Fort Worth, Texas.
169. **GOWEN, B. C.** (Buildings),  
Chief Engineer Wisconsin & Michigan Railroad, and L. M.  
C. F. T. Company, Peshtigo, Wis.
54. **GRAFTON, CHARLES E.,**  
Resident Engineer B. & O. Railroad,  
Akron, Ohio.
116. **GRAY, W. E.,**  
Second Vice-President New York Air Compressor Com-  
pany, New York, N. Y.
282. **GREIF, A. J.,**  
Superintendent Yazoo & Mississippi Valley Railroad,  
Vicksburg, Miss.
397. **GREINER, J. E.** (Iron and Steel Structures),  
Engineer B. & B., Baltimore & Ohio Railroad,  
Baltimore, Md.
108. **GRONDAHL, W. A.,**  
Resident Engineer Southern Pacific Company,  
Portland, Ore.
404. **GUTELIUS, F. P.** (Wooden Bridges and Trestles),  
Inspecting Engineer Canadian Pacific Railway,  
Montreal, Can.
184. **GWATHMEY, W. W., JR.,**  
Chief Engineer Seaboard Air Line.  
Portsmouth, Va.

## H

88. HAAS, L. G.,  
General Superintendent Baltimore & Ohio Railroad,  
Pittsburg, Pa.
330. HAMMOND, A. E.,  
Chief Engineer Columbia Southern Railway,  
Shaniko, Oregon.
251. HAMMOND, R. R. (Ties),  
Superintendent of Maintenance St. L. & S. F. Railroad,  
Springfield, Mo.
12. HANDY, E. A.,  
Chief Engineer Lake Shore & Michigan Southern Railway,  
Cleveland, Ohio.
429. HANKENSON, J. J.,  
Division Engineer C., M. & St. Paul Railway,  
Montgomery, Minn.
431. HANLEY, THOS. L. (Signs, Fences, Crossings, etc.),  
Assistant Engineer Grand Trunk Railway,  
Charlotte, Mich.
249. HANLON, W. B. (Water Service),  
Chief Engineer C. L. & W. Railway,  
Cleveland, Ohio.
350. HANNA, J. V. (Ballasting),  
Assistant Chief Engineer, St. L. & S. F. Railroad,  
Springfield, Mo.
84. HARAHAN, W. J. (Uniform Rules, Organization, etc.),  
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Chicago, Ill.
83. HARRIMAN, F. B.,  
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Dubuque, Iowa.
357. HART, E. E. (Ties),  
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Cleveland, Ohio.
70. HARTIGAN, J. G.,  
Superintendent St. L., I. M. & S. Railway,  
Little Rock, Ark.
374. HARVEY, A. E.,  
Division Engineer Chicago Great Western Railway,  
Red Wing, Minn.
414. HARVEY, C. C.,  
President and General Manager N. O. & N. E. Railroad,  
New Orleans, La.

182. HATCH, F. T.,  
Superintendent Terre Haute & Logansport Railway,  
Logansport, Ind.
288. HATCH, J. B.,  
Locating Engineer Ferrocarril del Norte,  
Guatemala City, Guatemala, C. A.
434. HAWGOOD, H.,  
Chief Engineer S. P. L. A. & S. L. Railroad,  
Los Angeles, Cal.
79. HAYDEN, W. W. (Ties),  
Assistant Engineer Yazoo & Mississippi Valley Railroad,  
Memphis, Tenn.
99. HECHLER, J. C.,  
Roadmaster Colorado Midland Railroad,  
Colorado City, Colo.
41. HENDRICKS, V. K.,  
Assistant to Engineer Maintenance-of-Way Baltimore &  
Ohio Railroad, Baltimore, Md.
209. HERBERT, A. P.,  
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tion Company, Colima, Mexico.
337. HERDEN, H.,  
Chief Engineer Buffalo & Susquehanna Railway,  
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81. HIGGINS, J. W.,  
General Superintendent of Transportation Illinois Central  
Railroad, Chicago, Ill.
151. HILLS, W. J.,  
Superintendent Nashville, Chattanooga & St. Louis Railway,  
Paducah, Ky.
344. HODGSDON, D. B.,  
General Manager Central of Guatemala Railway,  
Guatemala City, Guatemala, Central America.
453. HOHAGEN, A.,  
Civil Engineer,  
Valparaiso, Chili.
403. HOLBROOK, E. (Chairman Committee on Ballasting),  
Chief Engineer Kansas City Southern Railway,  
Kansas City, Mo.
123. HOOD, WILLIAM,  
Chief Engineer Southern Pacific Company,  
San Francisco, Cal.
250. HOTCHKISS, C. W.,  
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Chicago, Ill.

174. HOULISTON, GEORGE (Vice-Chairman Committee on Records, Reports and Accounts),  
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409. HOWARD, J. K.,  
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Decatur, Ill.
160. HOYT, C. B. (Track),  
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161. HOYT, W. E. (Masonry),  
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252. HUGHES, WILLIAM M. (Iron and Steel Structures),  
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156. HUNTER, JOSEPH,  
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Victoria, B. C.
310. HUNTER, W.,  
Chief Engineer Philadelphia & Reading Railway,  
Reading Terminal, Philadelphia, Pa.
97. HUTCHINS, J. C.,  
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145. ISAACS, JOHN D.,  
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341. JESSUP, E. M.,  
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93. JOHNSTON, A. W. (Director),  
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253. JONAH, F. G.,  
Chief Engineer Blackwell, Enid & Southwestern Railway,  
Blackwell, O. T.
91. JONES, PAUL,  
Engineer Maintenance-of-Way Pennsylvania Lines West,  
Louisville, Ky.
451. JOSSELYN, B. S.,  
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Louisville, Ky.

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142. KALK, CHARLES N.,  
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86. KELLEY, H. G. (Chairman Committee on Masonry),  
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Minneapolis, Minn.
392. KELLOGG, E. A.,  
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Boone, Iowa.
62. KENNEDY, H. A.,  
Assistant General Superintendent Western District Great  
Northern Railway, Spokane, Wash.
361. KENYON, WM. J. C.,  
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South Omaha, Neb.
319. KILLEBREW, O. D.,  
Resident Engineer Southern Railway,  
Columbia, S. C.
339. KIMBALL, W. H.,  
Civil Engineer,  
Davenport, Iowa.
255. KING, WILLIAM S.,  
Superintendent Illinois Central Railroad,  
Carbondale, Ill.
294. KING, W. S.,  
Chief Engineer Union Stock Yards & Railroad Company,  
South Omaha, Neb.
220. KINGMAN, LEWIS,  
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City of Mexico, Mexico.

15. KINNEAR, W. S.,  
Assistant General Superintendent Michigan Central Rail-  
road, Detroit, Mich.
106. KITTREDGE, GEORGE W. (President),  
Chief Engineer Cleveland, Cincinnati, Chicago & St. Louis  
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301. KLINE, THEO. D. (Uniform Rules, Organization, etc.),  
General Superintendent Central of Georgia Railway,  
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254. KNOWLTON, E. R.,  
Superintendent Chicago Terminal Transfer Railroad,  
Grand Central Passenger Station, Chicago, Ill.
401. KNOWLTON, H. H.,  
Engineer Maintenance-of-Way C., C., C. & St. L. Railway,  
Mt. Carmel, Ill.
107. KOEHLER, R.,  
Manager Southern Pacific Company in Oregon,  
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8. KRUTTSCHNITT, J. (Director),  
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340. KUDLICH, EDGAR,  
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256. LADEN, PATRICK,  
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206. LAHEY, J. A.,  
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Chicago, Ill.
52. LONDON, H. C. (Track),  
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way, Galetton, Pa.
408. LANGDON, A. H.,  
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Abbotsford, Wis.
124. LEE, E. H.,  
Engineer and General Roadmaster Chicago & Western In-  
diana Railroad, Chicago, Ill.
203. LEE, J. M.,  
Engineer and Superintendent Houston & Texas Central  
Railroad, Austin, Texas.
449. LEE, W. I.,  
Resident Engineer M., J. & K. C. Railroad,  
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257. **LEIGHTY, JOHN R.**,  
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214. **LEONARD, J. W.**,  
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338. **LEWIS, C. (Masonry)**,  
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49. **LINDSAY, C. E. (Track)**,  
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258. **LIST, CARLOS**,  
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273. **LOMBARD, A. G.**,  
Chief Engineer Montana Railroad,  
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441. **LOWETH, C. F. (Vice-Chairman Committee on Wooden Bridges)**,  
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146. **LUM, D. W. (Chairman Committee on Wooden Bridges)**,  
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458. **MCCARTHY, P. A.**,  
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Kennard, Texas.
325. **MCCARTNEY, H. M.**,  
Assistant Engineer S. P., L. A. & S. L. Railroad,  
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139. **MCCOURT, H.**,  
Superintendent Illinois Central Railroad,  
Chicago, Ill.
11. **MCDONALD, HUNTER (Second Vice-President)**,  
Chief Engineer Nashville, Chattanooga & St. Louis Railway,  
Nashville, Tenn.
35. **McFARLIN, W. K.**,  
Chief Engineer Delaware, Lackawanna & Western Railroad,  
Hoboken, N. J.

183. **McGONAGLE, W. A.**,  
Assistant Chief Engineer D. & I. R. Railroad,  
Duluth, Minn.
64. **McGUIGAN, F. H. (Director)**,  
Manager Grand Trunk Railway System,  
Montreal, Canada.
300. **McHENRY, E. H.**,  
Chief Engineer Canadian Pacific Railway,  
Montreal, Canada.
333. **McKAY, OWEN**,  
Chief Engineer Lake Erie & Detroit River Railway,  
Walkerville, Canada.
362. **McLOUGHLIN, W. B.**,  
Road Supervisor Illinois Central Railroad,  
Springfield, Ill.
166. **McNAB, W. (Chairman Committee on Roadway)**,  
Assistant Engineer Grand Trunk Railway,  
Montreal, Canada.
321. **McNAUGHER, D. W.**,  
Civil Engineer,  
Monongahela Bank Building, Pittsburg, Pa.
157. **MACPHERSON, DUNCAN (Track)**,  
Division Engineer Canadian Pacific Railway,  
Montreal, Canada.
26. **McVEAN, J. J.**,  
Civil Engineer,  
Grand Rapids, Mich.
53. **MACY, E. C. (Buildings)**,  
Assistant Engineer Chicago Great Western Railway,  
St. Paul, Minn.
50. **MALLARD, C. C. (Ties)**,  
Division Engineer Southern Pacific Company,  
Algiers, La.
296. **MALLORY, S. H.**,  
President Fulton, County Railway,  
Chariton, Iowa.
259. **MANNING, W. T. (Rail)**,  
Consulting Engineer Baltimore & Ohio Railroad,  
Equitable Building, Baltimore, Md.
391. **MARCHBANKS, JAMES**,  
Chief Engineer Wellington & Manawatu Railway,  
Wellington, New Zealand.
171. **MARKLEY, A. S. (Signaling and Interlocking)**,  
Superintendent Bridges and Buildings Chicago & Eastern  
Illinois Railroad, Danville, Ill.

366. MASON, J. D.,  
Resident Engineer Eastern Railway of Minnesota,  
West Superior, Wis.
411. MERRIAM, H. B.,  
Division Engineer Chicago Great Western Railway,  
Dubuque, Iowa.
17. MICHEL, WILLIAM (Iron and Steel Structures),  
Engineer Maintenance-of-Way Hocking Valley Railway,  
Columbus, Ohio.
18. MILES, H. D.,  
Assistant Superintendent Michigan Central Railroad,  
Jackson, Mich.
42. MILLARD, C.,  
General Manager Chicago, Peoria & St. Louis Railway,  
Springfield, Ill.
272. MILLARD, CHARLES S. (Signaling and Interlocking),  
Assistant Engineer Illinois Central Railroad,  
Chicago, Ill.
378. MILLER, F. C.,  
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418. MOCK, J. C. (Chairman Committee on Signaling and Interlocking),  
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Detroit, Mich.
232. MODJESKI, R.,  
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284. MOLITOR, F. A. (Vice-Chairman Committee on Ballasting),  
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218. MOLL, J. B.,  
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way, Old Colony Building, Chicago, Ill.
286. MONTAGUE, GEO.,  
Superintendent Track, Bridges and Buildings New Mexico  
& Arizona Railroad and Sonora Railway,  
Guaymas, Sonora, Mexico.
178. MONTFORT, R. (Rail),  
Chief Engineer Louisville & Nashville Railroad,  
Louisville, Ky.
72. MOORE, H. S.,  
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287. MOORE, ROBERT,  
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Laclede Building, St. Louis, Mo.

318. **MOORE, W. H.**,  
Bridge Engineer New York, New Haven & Hartford Railroad, New Haven, Conn.
10. **MOORE, W. S.**,  
Engineer Maintenance-of-Way Cleveland, Cincinnati, Chicago & St. Louis Railway, Galion, Ohio.
78. **MORENO, C. A.**,  
Chief Engineer St. Louis Transit Company,  
St. Louis, Mo.
260. **MORGAN, DWIGHT C.**,  
Assistant Engineer C., St. P., M. & O. Railway,  
Sioux City, Iowa.
192. **MORISON, GEORGE S.**,  
Civil Engineer,  
49 Wall Street, New York, N. Y.
172. **MORRISON, JOSEPH**,  
Resident Engineer and Superintendent B. & B., Central Vt. Railway, St. Albans, Vt.
313. **MORSE, G. F. (Yards and Terminals)**,  
Assistant Engineer Lehigh Valley Railroad,  
Buffalo, N. Y.
279. **MOUNTAIN, G. A. (Track)**,  
Chief Engineer Canada Atlantic Railway,  
Ottawa, Canada.
327. **MOUNTCASTLE, G. A.**,  
Roadmaster Southern Pacific Company,  
Deming, N. M.
387. **MURAKAMI, KYOICHI**,  
Chief Engineer Hoshu Railway Company,  
14 Wakamatsu Cho, Osaka, Japan.
281. **MURTAUGH, B.**,  
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172 Pacific Avenue, Jersey City, N. J.
416. **MYERS, E. T. D.**,  
President Richmond, Fredericksburg & Potomac Railroad,  
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## N

285. **NAUGLE, J. A.**,  
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321. **NEFF, NETTELTON (Yards and Terminals)**,  
Engineer Maintenance-of-Way Pennsylvania Lines West,  
Chicago, Ill.

- 261. NEFF, S. S.,  
Superintendent Elevated Division, Boston Elevated Railway,  
Sullivan Square Terminal, Charlestown, Mass.
- 45. NELSON, J. C. (Ties),  
Roadmaster Alabama Great Southern Railroad,  
Birmingham, Ala.
- 383. NEVILLE, M. A.,  
Engineer Maintenance-of-Way Peoria & Eastern Railway,  
Indianapolis, Ind.
- 276. NICHOL, J. H.,  
Assistant Engineer West Jersey & Seashore Railroad,  
Camden, N. J.
- 36. NICHOLSON, F. L. (Records, Reports and Accounts),  
Engineer Maintenance-of-Way Norfolk & Southern Rail-  
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- 375. NORTON, A. G.,  
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Wheeling, W. Va.
- 231. NORTON, CHARLES T.,  
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Railway, Ciudad Porfirio Diaz, Mexico.
- 417. NORTON, J. T.,  
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## O

- 204. OBORNE, JAMES (Uniform Rules, Organization, etc.),  
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## P

- 190. PALMER, W. S.,  
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- 68. PARADIS, F. E.,  
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Central Passenger Station, Chicago, Ill.
- 307. PARET, M. P. (Ballasting),  
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Seventh and Wyandotte Streets, Kansas City, Mo.
- 212. PARKHURST, H. W. (Chairman Committee on Buildings),  
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208. PAQUETTE, C. A. (Ballasting),  
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180. PATTERSON, F. M.,  
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293. PENNINGTON, E.,  
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Railway, Minneapolis, Minn.
7. PETERSON, P. ALEX.,  
Consulting Engineer Canadian Pacific Railway,  
Montreal, Canada.
38. PFAFFLIN, E. H.,  
Superintendent Evansville & Terre Haute Railway,  
Evansville, Ind.
263. PHILBRICK, ALVAH,  
Superintendent Illinois Central Railroad,  
Water Valley, Miss.
302. PHILLIPS, H. C. (Roadway),  
Assistant Superintendent Santa Fe Railway,  
Fort Madison, Iowa.
33. PIERCE, H.,  
Superintendent Chesapeake & Ohio Railway,  
Ronceverte, W. Va.
234. POLAND, WILLIAM B. (Chairman Committee on Track),  
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415. PORTER, H. T.,  
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311. RANDALL, E. J.,  
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Greenville, Pa.
417. RANNO, F. W.,  
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Terre Haute, Ind.
230. RAWN, I. G.,  
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126. RAYMER, A. R. (Vice-Chairman Committee on Buildings),  
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117. RICHARDS, J. T. (Rail),  
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63. RICHARDS, O. D. (Chairman Committee on Water Service),  
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356. ROBINSON, A. A.,  
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363. ROBINSON, A. F. (Wooden Bridges and Trestles),  
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48. ROBINSON, H. P.,  
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137. ROBINSON, J. B.,  
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226. ROCKWELL, SAMUEL,  
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4. RODD, THOMAS (Director),  
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265. RODGERS, J. G.,  
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346. ROGERS, E. I.,  
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264. ROGERS, M. H.,  
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413. ROSE, L. S.,  
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355. RUDD, A. H. (Signaling and Interlocking),  
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266. SAFFORD, H. R.,  
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377. SANDS, G. L.,  
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186. SANFORD, A. H.,  
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Allegheny, Pa.
138. SCARBOROUGH, F. W.,  
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433. SCHIDLOVSKY, THEO.,  
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143. SCHINDLER, A. D.,  
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336. SHAW, A. M.,  
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95. SHAW, LOUIS,  
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268. SHEAHAN, DENNIS,  
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Water Valley, Miss.
75. SHELAH, EDWARD,  
Division Engineer Philadelphia & Reading Railway,  
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162. SHEPARD, W.,  
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Boston, Mass.
455. SHERIFF, C. E.,  
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430. SHIRE, M. E.,  
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85. SIMS, C. S. (Chairman Committee on Yards and Terminals),  
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21. SLIFER, H. J. (Roadway),  
Superintendent Chicago & Northwestern Railway,  
Boone, Iowa.
61. SLOAN, DAVID,  
Chief Engineer of Construction Illinois Central Railroad,  
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436. SMITH, L. D. (Buildings),  
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Cleburne, Texas.
335. SNOW, J. P. (Chairman Committee on Iron and Steel Structures),  
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277. SOUTHGATE, R.,  
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120. SROUFE, C. C.,  
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- 443. STARBUCK, R. B.,  
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- 345. STEELE, HENRY M. (Signaling and Interlocking),  
Chief Engineer Central of Georgia Railway,  
Savannah, Ga.
- 24. STEVENS, F. S. (Yards and Terminals),  
Superintendent Philadelphia & Reading Railway,  
Reading, Pa.
- 352. STEVENS, T. S. (Signaling and Interlocking),  
Signal Engineer Atchison, Topeka & Santa Fe Railway,  
Topeka, Kas.
- 304. STIMSON, F. C. (Signs, Fences, Crossings, etc.),  
Roadmaster Chicago & Northwestern Railway,  
Sterling, Ill.
- 371. STITES, A. C.,  
Civil Engineer,  
Chicago, Ill.
- 425. STONEY, E. W.,  
Chief Engineer Madras Railway,  
Madras, India.
- 74. STOREY, W. B., JR. (Ballasting),  
Chief Engineer Atchison, Topeka & Santa Fe Railway,  
Topeka, Kas.
- 399. STUART, J. C.,  
General Superintendent Transportation Baltimore & Ohio  
Railroad, Baltimore, Md.
- 393. SUGIURA, SOZABURO,  
Superintendent Maintenance-of-Way Nippon Railway,  
Tokio, Japan.
- 98. SULLIVAN, A. W. (First Vice-President),  
Assistant Second Vice-President Illinois Central Railroad,  
Chicago, Ill.
- 448. SULLIVAN, J. G.,  
Division Engineer Construction Department, Canadian Pa-  
cific Railway, Winnipeg, Manitoba.
- 315. SWAIN, G. F. (Masonry),  
Professor of Civil Engineering Massachusetts Institute of  
Technology; Engineer Massachusetts Railroad Commis-  
sion; Member Boston Transit Commission,  
Boston, Mass.
- 130. SWAINE, E. L.,  
Resident Engineer Southern Pacific Company,  
Los Angeles, Cal.
- 347. SWANITZ, A. W. (Yards and Terminals),  
Consulting Engineer,  
315 Dearborn Street, Chicago, Ill.

## T

159. TAIT, THOMAS,  
Manager Eastern Lines Canadian Pacific Railway,  
Montreal, Canada.
440. TANABE, S.,  
Professor of Civil Engineering, University of Kyote,  
Kyote, Japan.
439. TAUSSIG, J. E.,  
Superintendent Wheeling & Lake Erie Railroad,  
Canton, Ohio.
299. TAYLOR, J. G.,  
Resident Engineer St. Louis & San Francisco Railroad,  
Peirce City, Mo.
426. TAYLOR, W. D.,  
Professor of Railway Engineering, University of Wisconsin,  
Madison, Wis.
111. THOMAS, J. W., JR.,  
General Manager Nashville, Chattanooga & St. Louis Rail-  
way, Nashville, Tenn.
290. THOMPSON, W. S.,  
Assistant Engineer Chautauqua Division Pennsylvania Rail-  
road, Oil City, Pa.
1. TORREY, A. (Director),  
Chief Engineer Michigan Central Railroad,  
Detroit, Mich.
215. TRATMAN, E. E. RUSSELL (Yards and Terminals),  
Resident Editor Engineering News,  
Monadnock Block, Chicago, Ill.
320. TRAVIS, O. J. (Wooden Bridges and Trestles),  
Superintendent of Bridges Illinois Central Railroad,  
106 Seventy-sixth Street, Chicago, Ill.
67. TRIMBLE, ROBERT (Chairman Committee on Rail),  
Principal Assistant Engineer Pennsylvania Lines West,  
Pittsburg, Pa.
428. TRIPPEER, A. G.,  
Resident Engineer Wabash Railroad,  
Peru, Ind.
372. TRUEMAN, HARMON,  
Chief Engineer Morden Frog & Crossing Works,  
The Rookery, Chicago, Ill.
359. TURK, J. E. (Records, Reports and Accounts),  
Superintendent Philadelphia & Reading Railway,  
Reading, Pa.

379. TUTHILL, JOB (Wooden Bridges and Trestles),  
Bridge Engineer Pere Marquette Railroad,  
Detroit, Mich.
112. TWEEDY, R. B.,  
Milwaukee, Wis.
364. TYE, W. F. (Roadway),  
Chief Engineer of Construction Canadian Pacific Railway,  
Montreal, Canada.

## U

155. UNDERWOOD, F. D.,  
President Erie Railroad,  
New York, N. Y.

## V

195. VAN VLECK, W. G.,  
General Manager Atlantic System Southern Pacific Com-  
pany, Houston, Texas.
103. VAUGHAN, G. W.,  
Division Engineer N. Y. C. & H. R. Railroad,  
Buffalo, N. Y.
158. VAUGHN, G. W.,  
Engineer in Charge of Track Elevation A., T. & S. F.,  
C., M. & N., and C. & A. Railways, 2476 Archer  
Avenue, Chicago, Ill.

## W

396. WALKER, G. M., JR. (Ballasting),  
Assistant Engineer and Roadmaster K. C. Belt Railway,  
Kansas City, Mo.
122. WALKER, I. O. (Wooden Bridges and Trestles),  
Assistant Engineer Nashville, Chattanooga & St. Louis Rail-  
way, Paducah, Ky.
57. WALLACE, H. U. (Ballasting),  
Superintendent Illinois Central Railroad,  
Freeport, Ill.
3. WALLACE, J. F. (Past-President),  
Assistant General Manager Illinois Central Railroad,  
Chicago, Ill.
76. WALLACE, J. H.,  
Engineer Maintenance-of-Way Pacific System Southern  
Pacific Company, San Francisco, Cal.

349. WASHBURN, E. C.,  
General Manager Bismarck, Washburn & Great Falls Rail-  
way, Bismarck, N. D.
188. WASHINGTON, L. A.,  
Chief Engineer Gulf & Ship Island Railway,  
Gulfport, Miss.
354. WATSON, THOS.,  
Resident Engineer Western Railways of Australia,  
Geraldton, Western Australia.
421. WEATHERLY, E. P.,  
Resident Engineer St. L., K. & N. W. Railway,  
Hannibal, Mo.
37. WEBSTER, G. H. (Records, Reports and Accounts),  
General Tie Agent Canadian Pacific Railway,  
Montreal, Can.
306. WEBSTER, WM. R. (Vice-Chairman Committee on Rail),  
Consulting and Inspecting Engineer,  
411 Walnut Street, Philadelphia, Pa.
127. WENDT, EDWIN F. (Chairman Com. on Records, Reports and Accts.),  
Assistant Engineer Pittsburg & Lake Erie Railroad,  
Pittsburg, Pa.
69. WHEATON, L. H.,  
Superintendent and Chief Engineer Halifax & Yarmouth  
Railway, Yarmouth, N. S.
228. WHITE, H. F.,  
Chief Engineer Burlington, Cedar Rapids & Northern Rail-  
way, Cedar Rapids, Iowa.
66. WHITE, I. F.,  
Superintendent Track and Structures Cincinnati, Hamilton  
& Dayton Railway, Hamilton, Ohio.
92. WHITTELSEY, T. F. (Director),  
General Manager Toledo Terminal Railway,  
Toledo, Ohio.
60. WHITTEMORE, D. J.,  
Chief Engineer Chicago, Milwaukee & St. Paul Railway,  
Chicago, Ill.
14. WICKHAM, C. E. (Rail),  
General Roadmaster Chicago, Rock Island & Pacific Railway,  
Chicago, Ill.
405. WIGHT, R. H.,  
Division Engineer Iowa Central Railway,  
Marshalltown, Iowa.
185. WILGUS, W. J.,  
Chief Engineer New York Central & Hudson River Rail-  
road, New York, N. Y.

104. WILLARD, DANIEL,  
Third Vice-President Erie Railroad,  
New York, N. Y.
271. WILLIAMS, H. R.,  
General Manager Chicago, Milwaukee & St. Paul Railway,  
Chicago, Ill.
32. WILLIAMS, W. D.,  
Chief Engineer Cincinnati Northern Railroad,  
Van Wert, Ohio.
9. WILSON, C. A. (Water Service),  
Chief Engineer Cincinnati, Hamilton & Dayton Railway,  
Cincinnati, Ohio.
270. WILSON, J. T.,  
Chief Engineer Pittsburg, Connellsville & Wheeling Rail-  
way, Wheeling, W. Va.
278. WOODS, H. A.,  
Assistant Engineer Chicago & Grand Trunk Railway,  
Detroit, Mich.
101. WOODWARD, E. K. (Records, Reports and Accounts),  
Engineer Maintenance-of-Way Wabash Railroad,  
Detroit, Mich.
292. WOODWARD, ROLAND,  
Chief Engineer Jacksonville & Southwestern Railroad,  
Jacksonville, Fla.
200. WOODWORTH, G. B. (Rail),  
Rail Inspector Chicago, Milwaukee & St. Paul Railway,  
Chicago, Ill.
395. WORCESTER, J. R. (Iron and Steel Structures),  
Consulting Engineer,  
Boston, Mass.
412. WRIGHT, J. T.,  
President and General Manager M., D. & S. Railway,  
Macon, Ga.

## Y

456. YAMAGUCHI, JUNNOSUKE,  
Civil Engineer, Chief Engineer Sanyo Railway, Master of  
Engineering Sanyo Railway Co., Kobe, Japan.

## Z

207. ZIESING, A.,  
Western Manager American Bridge Company,  
Monadnock Block, Chicago, Ill.

**DECEASED MEMBERS.**

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	DATE OF DEATH.
BURKE, S. E.....	October 17, 1900
CAFFREY, RICHARD.....	September 26, 1899
CARPENTER, C. A.....	November 11, 1899
CASEY, D. J.....	June 29, 1900
CLARKE, L. H.....	March 20, 1900
CURTIS, W. G.....	June 15, 1900
HALL, FERDINAND.....	November 22, 1899
KIDDER, J. F.....	April 10, 1901
MAHL, J. T.....	March 30, 1901
O'MELVENY, J. C.....	October 3, 1899
QUINLAN, G. A.....	August 29, 1901
SCHMIDT, H. W.....	February 11, 1901
TAYLOR, J. W.....	December 26, 1901

**MEMBERSHIP AND MILEAGE OF RAILWAYS REPRESENTED  
IN THE AMERICAN RAILWAY ENGINEERING AND  
MAINTENANCE-OF-WAY ASSOCIATION.**

Name of Road and Membership.	Members.	Mileage.
Alabama Great Southern Railroad.....	1	360
J. C. Nelson, Birmingham, Ala.		
Alabama & Vicksburg Railway.....	1	140
Edward Ford, Vicksburg, Miss.		
Ann Arbor Railroad.....	1	292
O. D. Richards, Toledo, Ohio.		
Atchison, Topeka & Santa Fe Railway.....	6	4,818
James Dun, Chicago, Ill.		
W. B. Storey, Jr., Topeka, Kan.		
A. F. Robinson, Topeka, Kan.		
T. S. Stevens, Topeka, Kan.		
H. C. Phillips, Fort Madison, Iowa.		
G. W. Vaughn, Chicago, Ill.		
Atlantic & Birmingham Railroad.....	1	70
A. Bonnyman, Waycross, Ga.		
Baltimore & Ohio Railroad.....	19	4,357
W. T. Manning, Baltimore, Md.		
C. S. Sims, New York, N. Y.		
J. C. Stuart, Baltimore, Md.		
L. G. Haas, Pittsburg, Pa.		
M. L. Byers, Baltimore, Md.		
J. E. Greiner, Baltimore, Md.		
D. D. Carothers, Chicago, Ill.		
W. B. Hanlon, Cleveland, Ohio.		
W. B. Poland, Pittsburg, Pa.		
A. G. Norton, Wheeling, W. Va.		
J. G. Bloom, Newcastle, Pa.		
J. H. Abbott, Cleveland, Ohio.		
V. K. Hendricks, Baltimore, Md.		
C. E. Bryan, Parkersburg, W. Va.		
C. Lewis, Baltimore, Md.		
T. J. Frazier, Zanesville, Ohio.		
L. G. Curtis, Garrett, Ind.		
C. E. Grafton, Akron, Ohio.		
J. R. Leighty, Newark, Ohio.		

## MILEAGE OF ROADS AND MEMBERS.

465

Name of Road and Membership.	Members.	Mileage.
Baltimore & Ohio Southwestern Railroad.....	3	928
I. G. Rawn, Cincinnati, Ohio.		
W. Archer, Cincinnati, Ohio.		
L. C. Fritch, Cincinnati, Ohio.		
Bessemer & Lake Erie Railroad.....	2	211
H. T. Porter, Greenville, Pa.		
E. J. Randall, Greenville, Pa.		
Bismarck, Washburn & Great Falls Railroad.....	1	45
E. C. Washburn, Bismarck, N. D.		
Blackwell, Enid & Southwestern Railway.....	2	83
Seely Dunn, Vernon, Texas.		
F. G. Jonah, Blackwell, O. T.		
Boise, Nampa & Owyhee Railway .....	1	81
J. M. Clark, Nampa, Idaho.		
Boston & Albany Railroad.....	1	394
Walter Shepard, Boston, Mass.		
Boston & Maine Railroad.....	1	2,308
J. P. Snow, Boston, Mass.		
Buffalo & Susquehanna Railroad.....	2	178
H. Herden, Galetton, Pa.		
H. C. Landon, Galetton, Pa.		
Buffalo, Attica & Arcade Railway.....	1	28
S. S. Bullis, Olean, N. Y.		
Buffalo, Rochester & Pittsburg Railway.....	1	475
J. M. Floesch, Rochester, N. Y.		
Burlington Route .....	6	8,225
Chicago, Burlington & Quincy,		
Howard Elliott, St. Louis, Mo.		
F. A. Delano, Chicago, Ill.		
W. L. Breckinridge, Chicago, Ill.		
Burlington's Missouri Lines,		
L. F. Goodale, St. Louis, Mo.		
F. M. Patterson, Hannibal, Mo.		
E. P. Weatherly, Hannibal, Mo.		
Canada Atlantic Railway.....	1	467
G. A. Mountain, Ottawa, Canada.		

Name of Road and Membership.	Members.	Mileage.
Canadian Pacific Railway.....	12	8,322
Thos. Tait, Montreal, Canada.		
P. Alex. Peterson, Montreal, Canada.		
E. H. McHenry, Montreal, Canada.		
W. F. Tye, Montreal, Canada.		
James Osborne, St. Johns, N. B.		
J. W. Leonard, Winnipeg, Man.		
A. C. Dennis, Montreal, Can.		
F. P. Gutelius, Montreal, Canada.		
G. H. Webster, Montreal, Canada.		
D. MacPherson, Montreal, Canada.		
A. L. Buck, Winnipeg, Man.		
J. G. Sullivan, Winnipeg, Man.		
Central New England Railroad.....	1	181
C. H. Ewing, Hartford, Conn.		
Central of Georgia Railway.....	2	1,834
Theo. D. Kline, Savannah, Ga.		
Henry M. Steele, Savannah, Ga.		
Central Railroad of New Jersey.....	1	685
W. G. Besler, New York, N. Y.		
Central Vermont Railway.....	2	531
E. H. Fitzhugh, St. Albans, Vt.		
Jos. Morrison, St. Albans, Vt.		
Chesapeake & Ohio Railway.....	2	1,477
F. W. Scarborough, Richmond, Va.		
H. Pierce, Ronceverte, W. Va.		
Chicago Great Western Railway.....	5	1,271
F. R. Coates, St. Paul, Minn.		
E. C. Macy, St. Paul, Minn.		
A. E. Harvey, Red Wing, Minn.		
C. P. Cogswell, Jr., Red Wing, Minn.		
H. B. Merriam, Dubuque, Iowa.		
Chicago Union Transfer Railway.....	1	100
M. E. Shire, Chicago, Ill.		
Chicago & Alton Railway.....	3	908
S. M. Felton, Chicago, Ill.		
H. F. Baldwin, Chicago, Ill.		
F. C. Miller, Springfield, Ill.		

Name of Road and Membership.	Members.	Mileage.
Chicago & Eastern Illinois Railroad.....	4	727
M. J. Carpenter, Chicago, Ill.		
W. S. Dawley, Chicago, Ill.		
A. S. Markley, Danville, Ill.		
Ralph McCalman, Danville, Ill.		
Chicago & Northwestern Railway.....	5	5,577
W. A. Gardner, Chicago, Ill.		
R. H. Aishton, Chicago, Ill.		
H. J. Slifer, Boone, Iowa.		
F. C. Stimson, Sterling, Ill.		
E. A. Kellogg, Boone, Iowa.		
Chicago & Western Indiana Railway.....	1	48
E. H. Lee, Chicago, Ill.		
Chicago Junction Railway .....	1	385
J. B. Cox, Chicago, Ill.		
Chicago, Milwaukee & St. Paul Railway.....	7	6,609
H. R. Williams, Chicago, Ill.		
D. J. Whittemore, Chicago, Ill.		
J. B. Moll, Chicago, Ill.		
C. F. Loweth, Chicago, Ill.		
G. B. Woodworth, Chicago, Ill.		
J. C. Sesser, Chicago, Ill.		
J. J. Hankenson, Montgomery, Minn.		
Chicago, St. Paul, Minn. & Omaha Railway.....	1	1,557
D. C. Morgan, Sioux City, Iowa.		
Chicago, Peoria & St. Louis Railway.....	1	289
Curtiss Millard, Springfield, Ill.		
Chicago, Rock Island & Pacific Railway.....	3	4,354
W. E. Dauchy, Chicago, Ill.		
W. H. Davisson, Chicago, Ill.		
C. E. Wickham, Chicago, Ill.		
Chicago Terminal Transfer Railroad.....	4	208
J. N. Faithorn, Chicago, Ill.		
F. E. Paradis, Chicago, Ill.		
E. R. Knowlton, Chicago, Ill.		
J. A. Lahey, Chicago, Ill.		
Chihuahua & Pacific Railroad .....	1	125
F. W. Andros, Chihuahua, Mex.		

Name of Road and Membership.	Members.	Mileage.
Choctaw, Oklahoma & Gulf Railroad .....	1	650
F. A. Molitor, Little Rock, Ark.		
Cincinnati, Hamilton & Dayton Railway.....	2	621
C. A. Wilson, Cincinnati, Ohio.		
I. F. White, Hamilton, Ohio.		
Cincinnati Northern Railroad.....	2	403
J. B. Flanders, Toledo, Ohio.		
W. D. Williams, Van Wert, Ohio.		
Cleveland, Cincinnati, Chicago & St. Louis Railway.....	6	2,290
George W. Kittredge, Cincinnati, Ohio.		
Hadley Baldwin, Indianapolis, Ind.		
H. H. Knowlton, Mt. Carmel, Ill.		
W. S. Moore, Galion, Ohio.		
L. S. Rose, Mattoon, Ill.		
R. H. Simpson, Wabash, Ind.		
Colorado & Southern Railroad.....	1	1,142
H. W. Cowan, Denver, Colo.		
Colorado Midland Railway.....	1	336
J. C. Hechler, Colorado Springs, Colo.		
Columbia & Southern Railroad.....	1	70
A. E. Hammond, Shaniko, Ore.		
Columbus, Sandusky & Hocking Railway.....	1	267
S. D. Pugh, Columbus, Ohio.		
Davenport, Rock Island & Northwestern Railway.....	1	53
Chas. E. Sheriff, Davenport, Iowa.		
Delaware, Lackawanna & Western Railroad.....	3	952
W. K. McFarlin, Hoboken, N. J.		
A. H. Rudd, Hoboken, N. J.		
R. W. Day, Hoboken, N. J.		
Delaware, Susquehanna & Schuylkill Railroad.....	1	76
Edgar Kudlich, Drifton, Pa.		
Detroit Southern Railroad .....	1	371
Geo. Crocker, Springfield, Ohio.		
Duluth & Iron Range Railroad.....	1	161
W. A. McGonagle, Duluth, Minn.		
Eastern Texas Railroad .....	1	52
P. A. McCarthy, Kennard, Texas.		
Elgin, Joliet & Eastern Railway.....	1	208
J. F. Cassell, Joliet, Ill.		

## MILEAGE OF ROADS AND MEMBERS.

469

Name of Road and Membership.	Members.	Mileage.
El Paso & Rock Island Route.....	1	336
W. E. Condon, Alamogordo, N. M.		
Erie Railroad .....	3	1,791
F. D. Underwood, New York, N. Y.		
Daniel Willard, New York, N. Y.		
J. R. W. Davis, Jersey City, N. J.		
Esquimault & Nanaimo Railway.....	1	80
Jos. Hunter, Victoria, B. C.		
Evansville & Terre Haute Railway.....	1	162
E. H. Pfafflin, Evansville, Ind.		
Federal District Railway of Mexico.....	1	220
H. P. Bradford, City of Mexico.		
Ferrocarril del Norte.....	1	...
J. B. Hatch, Guatemala City, Guatemala, C. A.		
Fremont, Elkhorn & Missouri Valley Railroad.....	1	1,332
G. F. Bidwell, Omaha, Neb.		
Fulton County Railroad.....	1	61
S. H. Mallory, Chariton, Iowa.		
Grand Trunk Railway.....	5	4,179
F. H. McGuigan, Montreal, Canada.		
W. McNab, Montreal, Canada.		
M. S. Blaiklock, Montreal, Canada.		
H. A. Woods, Detroit, Mich.		
T. L. Hanley, Charlotte, Mich.		
Great Northern Railway.....	3	4,969
H. A. Kennedy, Spokane, Wash.		
J. D. Mason, West Superior, Wis.		
A. G. Lombard, Ravalli, Mont.		
Guatemala Central Railway.....	1	113
D. B. Hodgsdon, Guatemala City, Guatemala, C. A.		
Gulf & Ship Island Railway.....	1	250
L. A. Washington, Gulfport, Miss.		
Gulf, Colorado & Santa Fe Railway.....	4	1,127
C. F. W. Felt, Galveston, Texas.		
L. Beauman, Cleburne, Texas.		
J. C. Christy, Temple, Texas.		
L. D. Smith, Cleburne, Texas.		

Name of Road and Membership.	Members.	Mileage.
Halifax & Yarmouth Railway.....	1	50
L. H. Wheaton, Yarmouth, N. S.		
Hocking Valley Railroad.....	1	346
Wm. Michel, Columbus, Ohio.		
Hoshu Railway of Japan.....	1	52
Kyoichi Murakami, Osaka, Japan.		
Houston & Texas Central Railroad.....	1	659
J. M. Lee, Austin, Texas.		
Illinois Central Railroad.....	33	4,265
J. F. Wallace, Chicago, Ill.		
A. W. Sullivan, Chicago, Ill.		
W. J. Harahan, Chicago, Ill.		
D. Sloan, Chicago, Ill.		
J. W. Higgins, Chicago, Ill.		
H. W. Parkhurst, Chicago, Ill.		
O. J. Travis, Chicago, Ill.		
C. Dougherty, Clinton, Ill.		
H. McCourt, Chicago, Ill.		
A. S. Baldwin, Chicago, Ill.		
R. B. Starbuck, Mattoon, Ill.		
A. H. Egan, Chicago, Ill.		
J. C. Dailey, Louisville, Ky.		
D. S. Bailey, Clinton, Ill.		
H. U. Wallace, Freeport, Ill.		
W. S. King, Carbondale, Ill.		
Alvah Philbrick, Water Valley, Miss.		
F. B. Harriman, Dubuque, Iowa.		
O. M. Dunn, New Orleans, La.		
H. R. Safford, Freeport, Ill.		
P. Galvin, Louisville, Ky.		
T. R. Cummins, Carbondale, Ill.		
P. Laden, Fulton, Ky.		
Dennis Sheahan, Water Valley, Miss.		
B. J. Gilleas, Cherokee, Iowa.		
H. Gilleas, Cherokee, Iowa.		
A. M. Shaw, Mattoon, Ill.		
E. I. Rogers, Memphis, Tenn.		
L. A. Downs, Louisville, Ky.		
L. L. Dagron, New Orleans, La.		
H. R. Dill, Evansville, Ind.		
Chas. S. Millard, Chicago, Ill.		
W. B. McLoughlin, Springfield, Ill.		

# MILEAGE OF ROADS AND MEMBERS.

471

Name of Road and Membership.	Members.	Mileage.
Jacksonville & Southwestern Railway.....	1	90
Roland Woodward, Jacksonville, Fla.		
Kansas City Belt Railway.....	1	50
G. M. Walker, Jr., Kansas City, Mo.		
Kansas City, Mexico & Orient Railway.....	2	365
M. P. Paret, Kansas City, Mo.		
W. W. Colpitts, Kansas City, Mo.		
Kansas City Southern Railway.....	2	765
E. Holbrook, Kansas City, Mo.		
B. F. Dickson, Kansas City, Mo.		
Kentucky & Indiana Bridge & Railroad Co.....	1	20
B. S. Josselyn, Louisville, Ky.		
Lake Erie & Detroit River Railway.....	1	232
Owen McKay, Walkerville, Canada.		
Lake Erie & Western Railway.....	1	719
G. C. Cleveland, Indianapolis, Ind.		
Lake Shore & Michigan Southern Railway.....	4	1,416
E. A. Handy, Cleveland, Ohio.		
Samuel Rockwell, Cleveland, Ohio.		
F. E. Bissell, Cleveland, Ohio.		
R. O. Rote, Cleveland, Ohio.		
Lake Superior & Ishpeming Railway.....	1	66
J. F. Deimling, Marquette, Mich.		
Lehigh Valley Railroad.....	3	1,398
Walter Berg, New York, N. Y.		
E. B. Ashby, South Bethlehem, Pa.		
G. F. Morse, Buffalo, N. Y.		
Little Rock & Hot Springs Western Railroad.....	1	57
H. G. Fleming, Hot Springs, Ark.		
Long Island Railroad .....	1	393
C. L. Addison, Long Island City, N. Y.		
Louisville & Atlantic Railroad.....	1	76
A. I. Sabin, Irvine, Ky.		
Louisville & Nashville Railroad.....	1	3,465
R. Montfort, Louisville, Ky.		

Name of Road and Membership.	Members.	Mileage.
<b>Macon, Dublin &amp; Savannah Railroad</b> .....	2	92
J. T. Wright, Macon, Ga.		
D. B. Dunn, Macon, Ga.		
<b>Macon, Jackson &amp; Kansas City Railroad</b> .....	1	...
W. I. Lee, Hattiesburg, Miss.		
<b>Madras Railway</b> .....	1	844
E. W. Stoney, Madras, India.		
<b>Mexican Central Railway</b> .....	2	2,321
A. A. Robinson, Boston, Mass.		
Lewis Kingman, City of Mexico.		
<b>Mexican International Railway</b> .....	1	848
C. T. Norton, Porfirio Diaz, Mexico.		
<b>Mexican National Construction Company</b> .....	1	89
A. P. Herbert, Colima, Mexico.		
<b>Michigan Central Railroad</b> .....	5	1,662
A. Torrey, Detroit, Mich.		
W. S. Kinnear, Detroit, Mich.		
B. Douglas, Detroit, Mich.		
H. D. Miles, Jackson, Mich.		
J. C. Mock, Detroit, Mich.		
<b>Minneapolis &amp; St. Louis Railroad</b> .....	2	1,225
H. G. Kelley, Minneapolis, Minn.		
Iowa Central Railway,		
R. H. Wight, Marshalltown, Iowa.		
<b>Minneapolis, St. Paul &amp; Sault Ste. Marie Railway</b> ....	1	1,337
E. Pennington, Minneapolis, Minn.		
<b>Missouri, Kansas &amp; Texas Railway</b> .....	2	2,460
E. M. Collins, St. Louis, Mo.		
S. B. Fisher, St. Louis, Mo.		
<b>Missouri Pacific Railway</b> .....	4	5,326
St. Louis, Iron Mountain & Southern,		
H. Rohwer, St. Louis, Mo.		
Wm. Cotter, St. Louis, Mo.		
J. G. Hartigan, Little Rock, Ark.		
G. W. Gardner, Newport, Ark.		
<b>Mobile &amp; Ohio Railroad</b> .....	2	876
C. S. Clarke, St. Louis, Mo.		
C. F. Blue, Cairo, Ill.		

# MILEAGE OF ROADS AND MEMBERS.

473

Name of Road and Membership.	Members.	Mileage.
Moscow-Kursk Railroad .....	1	692
Theo. Schidlovsky, Moscow, Russia.		
Nashville, Chattanooga & St. Louis Railway.....	4	1,189
J. W. Thomas, Jr., Nashville, Tenn.		
Hunter McDonald, Nashville, Tenn.		
W. J. Hills, Paducah, Ky.		
I. O. Walker, Paducah, Ky.		
National Docks Railway.....	1	21
B. Murtaugh, Jersey City, N. J.		
National Railway of Tehuantepec.....	1	210
John B. Body, City of Mexico, Mexico.		
New Orleans & Northeastern Railway.....	1	196
C. C. Harvey, New Orleans, La.		
New York Central & Hudson River Railroad.....	5	6,066
W. J. Wilgus, New York, N. Y.		
H. Fernstrom, New York, N. Y.		
G. W. Vaughan, Buffalo, N. Y.		
C. E. Lindsay, Jersey Shore, Pa.		
G. S. Cheyney, Buffalo, N. Y.		
New York, Chicago & St. Louis Railway.....	3	523
A. W. Johnston, Cleveland, Ohio.		
E. E. Hart, Cleveland, Ohio.		
C. B. Hoyt, Bellevue, Ohio.		
New York, New Haven & Hartford Railroad.....	2	2,038
W. H. Moore, New Haven, Conn.		
E. P. Dawley, Boston, Mass.		
New York, Philadelphia & Norfolk Railroad.....	1	112
J. G. Rodgers, Cape Charles, Va.		
Nippon Railway of Japan.....	1	855
S. Sugiura, Tokio, Japan.		
Norfolk & Southern Railroad.....	1	146
F. L. Nicholson, Norfolk, Va.		
Norfolk & Western Railway.....	1	1,675
C. S. Churchill, Roanoke, Va.		
Northern Pacific Railway.....	2	5,242
W. L. Darling, St. Paul, Minn.		
J. M. Dixon, St. Paul, Minn.		

Name of Road and Membership.	Members.	Mileage
Ocos Railway .....	1	30
Carlos List, Ocos, Guatemala.		
Pennsylvania Lines West of Pittsburg .....	8	2,672
Thos. Rodd, Pittsburg, Pa.		
R. Trimble, Pittsburg, Pa.		
W. C. Cushing, Pittsburg, Pa.		
R. C. Barnard, Cambridge, Ohio.		
Paul Jones, Louisville, Ky.		
Nettelton Neff, Chicago, Ill.		
A. H. Sanford, Allegheny, Pa.		
E. G. Ericson, Pittsburg, Pa.		
Pennsylvania Railroad .....	4	5,064
J. T. Richards, Philadelphia, Pa.		
R. Bell, Buffalo, N. Y.		
Geo. Houliston, Buffalo, N. Y.		
W. S. Thompson, Oil City, Pa.		
Peoria & Eastern Railway .....	3	341
J. A. Barnard, Indianapolis, Ind.		
C. A. Paquette, Indianapolis, Ind.		
M. A. Neville, Indianapolis, Ind.		
Pere Marquette Railroad .....	4	1,901
Job Tuthill, Detroit, Mich.		
John Doyle, Detroit, Mich.		
G. H. Bristol, Grand Rapids, Mich.		
F. H. Alfred, Saginaw, Mich.		
Philadelphia & Reading Railway .....	5	1,455
Wm. Hunter, Philadelphia, Pa.		
W. A. Garrett, Reading, Pa.		
F. S. Stevens, Reading, Pa.		
J. E. Turk, Reading, Pa.		
Edward Shelah, Reading, Pa.		
Pittsburg & Lake Erie Railroad .....	4	180
J. A. Atwood, Pittsburg, Pa.		
A. R. Raymer, Pittsburg, Pa.		
E. F. Wendt, Pittsburg, Pa.		
E. W. Boots, McKeesport, Pa.		
Pittsburg & Western Railway .....	1	349
Paul Didier, Allegheny, Pa.		
Pittsburg, Connellsville & Wheeling Railway .....	1	100
J. T. Wilson, Wheeling, W. Va.		

## MILEAGE OF ROADS AND MEMBERS.

475

Name of Road and Membership.	Members.	Mileage.
Quebec Southern Railway.....	1	88
F. D. Anthony, Sorel, Quebec.		
Richmond, Fredericksburg & Potomac Railway.....	1	89
E. T. D. Myers, Richmond, Va.		
Rio Grande, Sierra Madre & Pacific Railway.....	1	160
J. P. Ramsey, El Paso, Texas.		
St. Louis, Kansas City & Colorado.....	1	81
G. L. Sands, St Louis, Mo.		
St. Louis & San Francisco Railway.....	4	3,332
A. J. Davidson, St. Louis, Mo.		
R. R. Hammond, Springfield, Mo.		
J. V. Hanna, Springfield, Mo.		
J. G. Taylor, Peirce City, Mo.		
San Pedro, Lo's Angeles & Salt Lake Railroad.....	3	52
H. Hawgood, Los Angeles, Cal.		
E. M. Jessup, Los Angeles, Cal.		
H. M. McCartney, Salt Lake City, Utah.		
Santa Fe, Prescott & Phoenix Railway.....	2	224
J. H. Emmert, Prescott, Ariz.		
W. A. Drake, Prescott, Ariz.		
San Francisco & San Joaquin Valley Railroad.....	1	373
A. D. Schindler, Stockton, Cal.		
Sanyo Railroad .....	1	258
Junnosuke Yamaguchi, Kobe, Japan.		
Seaboard Air Line.....	1	2,591
W. W. Gwathmey, Jr., Portsmouth, Va.		
South Haven & Eastern Railroad.....	1	37
G. E. Drew, Three Oaks, Mich.		
Southern Indiana Railway.....	1	148
F. W. Ranno, Terre Haute, Ind.		
Southern Pacific Company .....	19	7,964
J. Kruttschnitt, San Francisco, Cal.		
W. G. VanVleck, Houston, Texas.		
R. Koehler, Portland, Ore.		
Wm. Hood, San Francisco, Cal.		
J. H. Wallace, San Francisco, Cal.		
E. B. Cushing, Houston, Texas.		

Name of Road and Membership.	Members.	Mileage.
Southern Pacific Company—Continued.		
J. A. Naugle, Guaymas, Mexico.		
J. D. Isaacs, San Francisco, Cal.		
Geo. Montague, Guaymas, Mexico.		
T. Fitzgerald, Ogden, Utah.		
W. A. Grondahl, Portland, Ore.		
W. S. Palmer, Sacramento, Cal.		
J. B. Robinson, Sacramento, Cal.		
E. L. Swaine, Los Angeles, Cal.		
C. C. Sroufe, Tucson, Ariz.		
R. S. Culverwell, San Francisco, Cal.		
I. A. Cottingham, El Paso, Texas.		
C. C. Mallard, Algiers, La.		
G. A. Mountcastle, Deming, N. M.		
Southern Railway .....	7	6,740
C. H. Ackert, Washington, D. C.		
W. B. Peddle, Washington, D. C.		
D. W. Lum, Washington, D. C.		
R. Southgate, Salisbury, N. C.		
C. H. Hudson, Knoxville, Tenn.		
H. Baker, Charlotte, N. C.		
O. D. Killebrew, Columbia, S. C.		
Tennessee Central Railway.....	1	71
F. M. Bisbee, Nashville, Tenn.		
Terre Haute & Logansport Railroad.....	1	183
F. T. Hatch, Logansport, Ind.		
Toledo Terminal Railway.....	1	30
T. F. Whittelsey, Toledo, Ohio.		
Toledo, St. Louis & Western Railway.....	1	450
J. L. Frazier, Frankfort, Ind.		
Trans-Alaskan Railway .....	1	...
J. J. Frey, Seattle, Wash.		
Union Railway .....	1	57
E. C. Brown, Port Perry, Pa.		
Union Pacific Railroad.....	3	3,029
E. Dickinson, Omaha, Neb.		
J. B. Berry, Omaha, Neb.		
H. C. Ferris, Omaha, Neb.		

## MILEAGE OF ROADS AND MEMBERS.

477

Name of Road and Membership.	Members.	Mileage.
Union Stock Yards & Railroad Company.....	2	50
Wm. J. C. Kenyon, South Omaha, Neb.		
W. S. King, South Omaha, Neb.		
Vancouver, Victoria & Eastern Railway.....	1	360
W. I. Bassett, Grand Forks, B. C.		
Vera Cruz & Pacific Railroad.....	1	89
E. Barrington, Tierra Blanca, Mexico.		
Wabash Railroad .....	3	2,307
E. K. Woodward, Detroit, Mich.		
A. G. Trippeer, Peru, Ind.		
J. K. Howard, Decatur, Ill.		
Wellington & Manawatu Railway .....	1	...
James Marchbanks, Wellington, New Zealand.		
West Jersey & Seashore Railway.....	1	330
J. H. Nichol, Camden, N. J.		
Western Railways of Australia.....	1	1,355
Thos. Watson, Geraldton, W. Australia.		
Wheeling & Lake Erie Railroad.....	1	462
J. E. Taussig, Canton, Ohio.		
Wisconsin & Michigan Railroad.....	1	72
B. C. Gowen, Peshtigo, Wis.		
Wisconsin Central Lines.....	3	881
R. B. Tweedy, Milwaukee, Wis.		
C. N. Kalk, Milwaukee, Wis.		
A. H. Langdon, Abbotsford, Wis.		
Yazoo & Mississippi Valley Railroad.....	3	1,047
A. J. Greif, Vicksburg, Miss.		
W. W. Hayden, Memphis, Tenn.		
L. W. Baldwin, Memphis, Tenn.		
Miscellaneous .....	54	...
Total .....	425	176,717

## STANDING COMMITTEES AND OUTLINE OF WORK FOR THE YEAR 1902-3.

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### COMMITTEE ON ROADWAY.

1. Definitions of terms.
  2. Specifications, adaptable to various methods of work on new lines and revision of old lines—to include uniform classification of materials.
- W. McNAB, Assistant Engineer, Grand Trunk Railway System, Montreal, Canada, *Chairman*;  
C. DOUGHERTY, Superintendent, Illinois Central Railroad, Clinton, Ill., *Vice-Chairman*;  
C. FRANK ALLEN, Prof. of Railway Engineering, Mass. Institute of Technology, Boston, Mass.;  
HADLEY BALDWIN, Engineer Maintenance-of-Way, C. C. C. & St. L. Railway, Indianapolis, Ind.;  
A. C. DENNIS, Divisional Engineer, Con. Dept., Canadian Pacific Railway, Montreal, Canada;  
W. D. PENCE, Prof. of Civil Engineering, Purdue University, Lafayette, Ind.;  
H. C. PHILLIPS, Assistant Superintendent, Santa Fe Railway, Fort Madison, Ia.;  
H. J. SLIFER, Superintendent, Chicago & Northwestern Railway, Boone, Ia.;  
W. F. TYE, Chief Engineer of Construction, Canadian Pacific Railway, Montreal, Canada,

*Committee.*

### COMMITTEE ON BALLASTING.

1. Definitions of terms.
  2. Specifications for ballast.
  3. What constitutes ballasted track.
- E. HOLBROOK, Chief Engineer, Kansas City Southern Railway, Kansas City, Mo., *Chairman*;  
F. A. MOLITOR, Chief Engineer, Choctaw, Oklahoma & Gulf Railroad, Little Rock, Ark., *Vice-Chairman*;  
S. B. FISHER, Chief Engineer, M. K. & T. Railway, St. Louis, Mo.;  
J. V. HANNA, Asst. Chief Engineer, St. L. & S. F. Railroad, Springfield, Mo.;  
C. A. PAQUETTE, Superintendent, Peoria & Eastern Railway, Indianapolis, Ind.;

M. P. PARET, Chief Engineer, K. C. M. & O. Railway, Kansas City, Mo.;  
 W. B. STOREY, JR., Chief Engineer, Santa Fe Railway, Topeka, Kan.;  
 G. M. WALKER, JR., Asst. Engineer & Roadmaster, Kansas City Belt  
 Railway, Kansas City, Mo.;  
 H. U. WALLACE, Superintendent, Illinois Central Railroad, Freeport, Ill.,  
*Committee.*

COMMITTEE ON TIES.

1. Definitions of terms.
2. Specifications of untreated ties.
3. Inspection and classification of new ties.
4. Statistics.
5. Preservative processes.

E. B. CUSHING, Engineer Maintenance-of-Way, Southern Pacific Co., Atl.  
 System, Houston, Tex., *Chairman*;  
 ROBERT BELL, Superintendent, Pennsylvania Railroad, Buffalo, N. Y., *Vice-  
 Chairman*;  
 W. ARCHER, Principal Asst. Engineer, B. & O. S. W. R. R., Cincinnati, O.;  
 J. B. BERRY, Chief Engineer, Union Pacific Railroad, Omaha, Neb.;  
 O. CHANUTE, Consulting Engineer, Chicago, Ill.;  
 W. W. CURTIS, Consulting Engineer, Chicago, Ill.;  
 R. R. HAMMOND, Supt. of Maintenance, St. L. & S. F. R. R., Spring-  
 field, Mo.;  
 E. E. HART, Engineer, N. Y. C. & St. L. R. R., Cleveland, O.;  
 W. W. HAYDEN, Assistant Engineer, Y. & M. V. R. R., Memphis, Tenn.;  
 C. C. MALLARD, Division Engineer, Southern Pacific Company, Algiers,  
 La.;  
 J. C. NELSON, Roadmaster, Alabama Great Southern Railroad, Birming-  
 ham, Ala.;  
 S. M. ROWE, Consulting Engineer, Chicago, Ill.,  
*Committee.*

COMMITTEE ON RAIL.

1. Definitions of terms.
2. General specifications.

R. TRIMBLE, Principal Assistant Engineer, Pennsylvania Lines West of  
 Pittsburg, Pittsburg, Pa., *Chairman*;  
 WM. R. WEBSTER, Consulting and Inspecting Engineer, Philadelphia, Pa.,  
*Vice-Chairman*;  
 F. E. ABBOTT, Inspecting Engineer, Illinois Steel Company, Chicago, Ill.;  
 L. F. G. BOUSCAREN, Consulting Engineer, Chief Engineer, Water Works  
 Commission, Cincinnati, O.;  
 ROBT. W. HUNT, Consulting Engineer, Chicago, Ill.;  
 S. M. FELTON, President, Chicago & Alton Railway, Chicago, Ill.;  
 W. T. MANNING, Consulting Engineer, Baltimore & Ohio Railroad, Balti-  
 more, Md.;

- R. MONTFORT, Chief Engineer, Louisville & Nashville Railroad, Louisville, Ky.;
- J. T. RICHARDS, Engineer Maintenance-of-Way, Pennsylvania Railroad, Philadelphia, Pa.;
- C. E. WICKHAM, General Roadmaster, C. R. I. & P. Railway, Chicago, Ill.;
- G. B. WOODWORTH, Rail Inspector, C. M. & St. P. Ry., Chicago, Ill.,  
*Committee.*

## COMMITTEE ON TRACK.

1. Definitions of terms.
  2. Maintenance of Line, Maintenance of Surface and Maintenance of Gauge.
- W. B. POLAND, Division Engineer, Baltimore & Ohio Railroad, Pittsburg, Pa., *Chairman*;
- W. M. CAMP, Editor, Railway and Engineering Review, Chicago, Ill., *Vice-Chairman*;
- F. R. COATES, Chief Engineer, Chicago Great Western Railway, St. Paul, Minn.;
- JOHN DOYLE, Supt. of Tracks, Pere Marquette Railroad, Detroit, Mich.;
- GARRETT DAVIS, Asst. Chief Engineer, B. C. R. & Nor. R. R., Cedar Rapids, Ia.;
- C. B. HOYT, Chief Supervisor of Tracks, N. Y. C. & St. L. Railroad, Bellevue, O.;
- H. C. LANDON, Engineer Maintenance-of-Way, Buffalo & Susquehanna R. R., Galeton, Pa.;
- C. E. LINDSAY, Division Engineer, N. Y. C. & H. R. R. R., Jersey Shore, Pa.;
- G. A. MOUNTAIN, Chief Engineer, Canada Atlantic Railway, Ottawa, Canada;
- D. MACPHERSON, Division Engineer, Canadian Pacific Railway, Montreal, Canada;
- J. C. SESSER, Assistant Engineer, C. M. & St. P. Railway, Chicago, Ill.,  
*Committee.*

## COMMITTEE ON BUILDINGS.

1. Definitions of terms.
  2. Specifications.
  3. Passenger Stations.
- H. W. PARKHURST, Engineer B. & B., Illinois Central Railroad, Chicago, Ill., *Chairman*;
- A. R. RAYMER, Asst. Chief Engineer, Pittsburg & Lake Erie Railroad, Pittsburg, Pa., *Vice-Chairman*;
- H. F. BALDWIN, Chief Engineer, Chicago & Alton Railway, Chicago, Ill.;
- B. F. DICKSON, Engineer Maintenance-of-Way, Kansas City Southern Railway, Kansas City, Mo.;

- H. W. COWAN, Chief Engineer, Colorado & Southern Railway, Denver, Colo.;
- B. C. GOWEN, Chief Engineer, Wisconsin & Michigan Railroad, Peshtigo, Wis.;
- E. C. MACY, Assistant Engineer, Chicago Great Western Railway, St. Paul, Minn.;
- L. D. SMITH, Building Supervisor, G. C. & S. F. Railway, Cleburne, Tex.,  
*Committee.*

COMMITTEE ON WOODEN BRIDGES AND TRESTLES.

- 1. Definitions of terms.
- 2. Specifications.
- 3. Trestles.
- D. W. LUM, Engineer B. & B., Southern Railway, Washington, D. C.,  
*Chairman*;
- C. F. LOWETH, Eng. & Supt. B. & B., C. M. & St. P. Railway, Chicago,  
*Vice-Chairman*;
- I. O. WALKER, Asst. Engineer, N. C. & St. L. Railway, Paducah, Ky.;
- D. B. DUNN, Chief Engineer, M. D. & S. R. R., Macon, Ga.;
- F. P. GUTELIUS, Inspecting Engineer, Canadian Pacific Railway, Montreal,  
Canada;
- A. F. ROBINSON, Bridge Engineer, Santa Fe Railway System, Topeka,  
Kan.;
- JOB TUTHILL, Bridge Engineer, Pere Marquette Railroad, Detroit, Mich.;
- O. J. TRAVIS, Supt. Bridges, Illinois Central Railroad, Chicago, Ill.,  
*Committee.*

COMMITTEE ON MASONRY.

- 1. Definitions of terms.
- 2. Specifications.
- 3. Concrete Masonry and Cements.
- H. G. KELLEY, Chief Engineer, Minneapolis & St. Louis Railway, Minneapolis, Minn., *Chairman*;
- W. L. BRECKINRIDGE, Chief Engineer, Chicago, Burlington & Quincy Railroad, Chicago, Ill., *Vice-Chairman*;
- E. C. BROWN, Engineer Maintenance-of-Way, Union Railroad, Port Perry, Pa.;
- JOHN DEAN, Consulting Engineer, St. Louis, Mo.;
- C. F. W. FELT, Chief Engineer, G. C. & S. F. Railway, Galveston, Tex.;
- W. E. HOYT, Consulting Engineer, Rochester, N. Y.;
- C. LEWIS, Civil Engineer, New York, N. Y.;
- G. F. SWAIN, Prof. of Civil Engineering, Mass. Inst. of Technology, Boston, Mass.;
- M. W. COOLEY, Consulting Engineer, Boston, Mass.,  
*Committee.*

## COMMITTEE ON SIGNS, FENCES, CROSSINGS AND CATTLE-GUARDS.

1. Definitions of terms.
2. Specifications.
3. Fences and Cattle-guards.

- A. S. BALDWIN, Principal Assistant Engineer, Illinois Central Railroad, Chicago, Ill., *Chairman*;  
 E. G. ERICSON, Assistant Engineer, Pennsylvania Lines, Pittsburg, Pa., *Vice-Chairman*;  
 F. H. ALFRED, Assistant Engineer, Pere Marquette Railroad, Saginaw, Mich.;  
 J. B. FLANDERS, Gen. Supt., Cincinnati Northern Railroad, Toledo, O.;  
 T. L. HANLEY, Assistant Engineer, Grand Trunk Railway, Charlotte, Mich.;  
 F. C. STIMSON, Roadmaster, Chicago & Northwestern Railway, Sterling, Ill.;  
 C. H. EWING, Chief Engineer, Central New England Railroad, Hartford, Conn.,

*Committee.*

## COMMITTEE ON SIGNALING AND INTERLOCKING.

1. Definitions of terms.
2. Specifications.
3. Train-order Signals, Interlocking Signals, Block Signals.

- J. C. MOCK, Signal Engineer, Michigan Central Railroad, Detroit, Mich., *Chairman*;  
 W. C. CUSHING, Superintendent, Pennsylvania Lines West, Pittsburg, Pa., *Vice-Chairman*;  
 C. L. ADDISON, Supt. Trans., Long Island Railroad, Long Island City, N. Y.;  
 A. S. MARKLEY, Supt. B. & B., Chicago & Eastern Illinois Railroad, Danville, Ill.;  
 T. S. STEVENS, Signal Engineer, Santa Fe Railway System, Topeka, Kan.;  
 H. M. STEELE, Chief Engineer, Central of Georgia Railway, Savannah, Ga.;  
 A. H. RUDD, Signal Engineer, Del., Lack. & Western Railroad, Hoboken, N. J.;  
 C. S. MILLARD, Assistant Engineer, Illinois Central Railroad, Chicago, Ill.,

*Committee.*

## COMMITTEE ON RECORDS, REPORTS AND ACCOUNTS.

1. Definitions of terms.
  2. Specifications.
  3. Bridge Department Forms, to include Labor and Material Reports, Inspection Reports and Office Records.
- EDWIN F. WENDT, Assistant Engineer, Pittsburg & Lake Erie Railroad, Pittsburg, Pa., *Chairman*;  
 GEORGE HOULISTON, Assistant Engineer, Pennsylvania Railroad, Buffalo, N. Y., *Vice-Chairman*;

- E. K. WOODWARD, Engineer Maintenance-of-Way, Wabash Railroad, Detroit, Mich.;
- F. L. NICHOLSON, Engineer Maintenance-of-Way, Norfolk & Southern Railroad, Norfolk, Va.;
- G. H. WEBSTER, General Tie Agent, Canadian Pacific Railway, Montreal, Canada;
- L. F. GOODALE, Chief Engineer, Burlington's Missouri Lines, St. Louis, Mo.;
- J. E. TURK, Superintendent, Philadelphia & Reading Railway, Reading, Pa.,

*Committee.*

#### COMMITTEE ON UNIFORM RULES, ORGANIZATION, TITLES, ETC.

1. Definitions of terms.
2. List of subjects which will form a basis of a uniform code of rules for the Maintenance-of-Way Department.

- J. A. BARNARD, General Manager, Peoria & Eastern Railway, Indianapolis, Ind., *Chairman*;
- J. H. ABBOTT, Division Engineer, Baltimore & Ohio Railroad, Cleveland, O., *Vice-Chairman*;
- D. D. CAROTHERS, Superintendent, Baltimore & Ohio Railroad, Chicago, Ill.;
- R. H. AISHTON, Assistant General Manager, Chicago & Northwestern Railway, Chicago, Ill.;
- C. S. CLARKE, General Manager, Mobile & Ohio Railroad, St. Louis, Mo.;
- THEO. D. KLINE, Gen. Supt., Cen. of Georgia Railway, Savannah, Ga.;
- W. J. HARAHAN, Chief Engineer, Illinois Central Railroad, Chicago, Ill.;
- W. A. GARRETT, General Superintendent, Philadelphia & Reading Railway, Reading, Pa.;
- E. DICKINSON, General Manager, Union Pacific Railroad, Omaha, Neb.;
- JAMES OBORNE, Gen. Superintendent, Canadian Pacific Railway, St. Johns, N. B.,

*Committee.*

#### COMMITTEE ON WATER SERVICE.

1. Definitions of terms.
2. Character of water, giving analyses of good and bad water for boilers; also of compounds to counteract impurities.
3. Methods of purification.

- O. D. RICHARDS, Chief Engineer, Ann Arbor Railroad, Toledo, O., *Chairman*;
- J. L. FRAZIER, General Superintendent, T. St. L. & W. R. R., Frankfort, Ind., *Vice-Chairman*;
- C. A. WILSON, Chief Engineer, C. H. & D. Railway, Cincinnati, O.;
- W. B. HANLON, Chief Engineer, C. L. & W. Railway, Cleveland, O.;
- W. H. DAVISSON, Asst. Chief Engineer, C. R. I. & P. Railway, Chicago, Ill.,

*Committee.*

## COMMITTEE ON YARDS AND TERMINALS.

1. Definitions of terms.
2. Freight Terminals.

C. S. SIMS, General Superintendent, Baltimore & Ohio Railroad, New York, N. Y., *Chairman*;  
 W. G. BESLER, General Manager, Central Railroad of New Jersey, New York, N. Y., *Vice-Chairman*;  
 M. S. BLAIKLOCK, Superintendent, Grand Trunk Railway, Montreal, Canada;  
 J. B. COX, Chief Engineer, Chicago Junction Railway, Chicago, Ill.;  
 G. F. MORSE, Assistant Engineer, Lehigh Valley Railroad, Buffalo, N. Y.;  
 F. S. STEVENS, Superintendent, Philadelphia & Reading Railway, Reading, Pa.;  
 J. A. ATWOOD, Chief Engineer, Pittsburg & Lake Erie Railroad, Pittsburg, Pa.;  
 E. P. DAWLEY, Division Engineer, N. Y. N. H. & H. R. R., Boston, Mass.;  
 NETTELTON NEFF, Engineer Maintenance-of-Way, Pennsylvania Lines West, Chicago, Ill.;  
 E. E. R. TRATMAN, Resident Editor, Engineering News, Chicago, Ill.;  
 A. W. SWANITZ, Consulting Engineer, Chicago, Ill.,

*Committee.*

## COMMITTEE ON IRON AND STEEL STRUCTURES.

1. Definitions of terms.
2. Specifications for material and workmanship.

J. P. SNOW, Bridge Engineer, Boston & Maine Railroad, Boston, Mass., *Chairman*;  
 B. DOUGLAS, Bridge Engineer, Michigan Central Railroad, Detroit, Mich., *Vice-Chairman*;  
 JOHN BRUNNER, Asst. Gen. Supt., Illinois Steel Co., Chicago, Ill.;  
 T. L. CONDRON, Consulting Engineer, Chicago, Ill.;  
 C. L. CRANDALL, Prof. of R. R. Eng., Cornell University, Ithaca, N. Y.;  
 J. E. GREINER, Engineer B. & O., Baltimore & Ohio Railroad, Baltimore, Md.;  
 WM. M. HUGHES, Consulting Bridge Engineer, Chicago, Ill.;  
 WM. MICHEL, Engineer Maintenance-of-Way, Hocking Valley R. R., Columbus, O.;  
 C. C. SCHNEIDER, Vice-Prest., Am. Bridge Co., New York, N. Y.;  
 J. R. WORCESTER, Consulting Engineer, Boston, Mass.,

*Committee.*

## COMMITTEES OF THE BOARD OF DIRECTION.

<i>On Finance.</i>	<i>On Publications.</i>	<i>On Library.</i>
F. H. MCGUIGAN, Chairman.	A. TORREY, Chairman.	THOS. RODD, Chairman.
T. F. WHITTELSEY.	A. W. SULLIVAN.	A. W. JOHNSTON.
W. S. DAWLEY.	HUNTER McDONALD.	HUNTER McDONALD.
	L. C. FRITCH.	

# CONSTITUTION.

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## ARTICLE I.

### NAME, LOCATION, OBJECT AND MEANS.

SECTION 1. Name: The name of this Association shall be The American Railway Engineering and Maintenance-of-Way Association.

SECTION 2. Location: The offices of the Association shall be located in Chicago, Illinois.

SECTION 3. Object: The object of this Association shall be the advancement of knowledge pertaining to the scientific and economical location, construction, operation and maintenance of railroads.

SECTION 4. Means: The means to be employed for this purpose shall be as follows:

(a) Meetings for the reading and discussion of papers and for social intercourse.

(b) The investigation of matters pertaining to the objects of this Association through Standing and Special Committees.

(c) The publication of papers, reports and discussions.

(d) The maintenance of a library.

## ARTICLE II.

### MEMBERSHIP.

SECTION 1. The Membership of this Association shall be divided into two classes, viz., Active and Honorary.

SECTION 2. Any Civil, Mechanical or Electrical Engineer, who has had five years' experience in the location, construction or maintenance of railroads; and any railroad official who is responsible for or has supervision of maintenance-of-way matters (embracing all grades of officials, from General Managers to Engineers of Maintenance-of-Way in charge of Divisions, inclusive), or railroad men bearing other titles but performing similar duties, shall be eligible for Active Membership.

SECTION 3. An Honorary Member shall be a person of acknowledged eminence in Railway Engineering or management. The number of Honorary Members shall be limited to ten. Honorary Members shall have all the rights of Active Members, except those of voting and holding office.

SECTION 4. Persons who are exclusively engaged in the sale or promotion of railroad patents or appliances shall not be eligible for membership in this Association.

## ARTICLE III.

## ADMISSIONS AND EXPULSIONS.

SECTION 1. The Charter Membership shall consist of all persons who are eligible for Membership under the provisions of Article II, and who may make application to the Secretary of the Preliminary Organization and receive a majority of the votes of the Organization Committee (composed of the Chairman and Secretary of the Preliminary Organization and the five persons constituting the Committee to prepare a Constitution and By-Laws), and pay the entrance fee, hereinafter provided for, within thirty days from the date of the adoption of this Constitution.

SECTION 2. After the expiration of said thirty days persons desiring Membership shall make application on the form prescribed by the Board of Direction, referring to five Members. The Board of Direction, through its Secretary or a Committee on Applications, shall make such investigations of the candidate's fitness as may be deemed necessary. The Secretary of the Association will furnish copies of the information obtained, together with a copy of the application, to each member of the Board of Direction. At any time, thirty days after the filing of the application, the admission of the applicant shall be voted on by letter ballot by each Member of the Board of Direction. Affirmative votes by two-thirds of the Board of Direction shall elect the candidates.

SECTION 3. All elected candidates shall be duly notified, and shall subscribe to the Constitution and By-Laws, on forms prescribed by the Board of Direction, and transmit to the Secretary the entrance fee herein-after prescribed. If this provision be not complied with within six months the election shall be considered null and void.

SECTION 4. Honorary Members shall be proposed by at least ten Active Members to the Secretary. Each Member of the Board of Direction shall be furnished with a copy of the proposal, and after thirty days votes by ballot shall be taken by the Board of Direction thereon. If a candidate shall receive the unanimous vote of said Board he shall be declared elected an Honorary Member.

SECTION 5. Expulsions: On written charges preferred by ten or more Members, addressed to the Secretary of the Association, the Member complained of shall be served with a copy of said charges, and shall be called upon to show cause to the Board of Direction why he should not be expelled from the Association. Thirty days after said Member has been properly notified of the charges preferred against him, a vote shall be taken on his expulsion, and he may be expelled upon a two-thirds vote of the Board of Direction.

SECTION 6. Resignations: It shall be the duty of the Board of Direction to accept the resignation, tendered in writing, of any Member whose dues are fully paid up.

## ARTICLE IV.

## DUES.

SECTION 1. An initiation fee of \$10.00 shall be payable to the Secretary with each application for Membership; this sum is to be returned to the applicant, however, who is not elected.

SECTION 2. The annual dues of this Association shall be \$10.00, payable annually, during the first three months of each calendar year for the current year.

SECTION 3. Any person whose dues remain three months in arrears shall be notified of same by the Secretary. Should the dues in arrears not be paid prior to July 1st of each year, the delinquent Member shall lose his right to vote, but shall continue to receive the publications of the Association. Should his dues become nine months in arrears he shall be notified on the form prescribed by the Board of Direction; and if said dues are not paid by the first of the following year, he shall forfeit his connection with the Association without further action.

SECTION 4. The Board of Direction may, however, extend the time of payment of dues and for the application of these penalties. The Board of Direction may also, for sufficient cause, excuse from payment the annual dues of any Member who, from ill-health, advanced age or other good reason, is unable to pay his dues.

## ARTICLE V.

## OFFICERS.

SECTION 1. The officers of this Association shall consist of a President, two Vice-Presidents, six Directors, a Secretary and a Treasurer, who shall constitute the Board of Direction, in which the government of the Association shall be vested, and who shall act as Trustees and have the custody of all property belonging to the Association.

SECTION 2. The term of office of the President, Secretary and Treasurer shall be one year; of the Vice-Presidents two years, and of the Directors three years; with the exception, however, that at the first election of officers after the adoption of this Constitution one Vice-President and two Directors shall be elected to serve one year; one Vice-President and two Directors for two years, and two Directors for three years; provided also, that after the first annual election one Vice-President and two Directors shall be elected each year in addition to the President, Secretary and Treasurer.

SECTION 3. The first election of officers under this Constitution shall be held by the Preliminary Organization of Charter Members immediately after the adoption of this Constitution, and the officers so elected shall at once assume office. The term of each officer shall begin at the close of each election and shall continue until his successor shall be elected at the expiration of his term as above set forth.

SECTION 4. Any vacancy in the office of President shall be filled by the senior Vice-President. A vacancy in the office of Vice-President shall be filled by election from among the Directors. In case of the disability or neglect in the performance of his duty of any officer of this Association, the Board of Direction shall have power to declare the office vacant. Vacancies in any office for the unexpired term shall be filled by the Board of Direction, except vacancy in office of President, as provided above.

SECTION 5. At least thirty days before each annual meeting, the Board of Direction, who shall act as a Nominating Committee, shall nominate to the Association a list of officers for the next ensuing year. At any time prior to the thirty days before the annual meeting any ten Members of the Association shall have the right to nominate officers for the ensuing year. Thirty days prior to each annual meeting the Secretary shall issue ballots to each Member of record in good standing, with a list of the several candidates to be voted upon, whose names shall be placed in alphabetical order if more than one person is nominated for any position. Ballots shall be placed in a sealed envelope, with the name of the Member voting indorsed thereon, and deposited with the Secretary at any time previous to the annual meeting. At the annual meeting three tellers shall be appointed, who shall open and count the ballots and report the result thereof. The majority of votes cast for any nominee shall determine his election.

## ARTICLE VI.

### MANAGEMENT.

SECTION 1. The President shall have a general supervision of the affairs of the Association. He shall preside at all meetings of the Association and at all meetings of the Board of Direction, and shall be ex-officio Member of all Committees.

The Vice-Presidents in order of seniority shall preside at meetings in the absence of the President, and discharge his duties in case of a vacancy in his office.

SECTION 2. The Board of Direction shall manage the affairs of the Association and shall have full power to control and regulate all matters not otherwise provided for in the Constitution.

SECTION 3. The Treasurer shall receive all moneys and deposit same in the name of the Association, and shall receipt to the Secretary therefor. He shall invest all funds not needed for current disbursements as shall be ordered by the Board of Direction. He shall pay all bills, when properly certified and audited by the Board of Direction, and make such reports as may be called for by the Board of Direction.

SECTION 4. The Secretary shall be, under the direction of the President and Board of Direction, the Executive Officer of the Association. He shall attend all meetings of the Association and of the Board of Direction; prepare the business therefor, and duly record the proceedings thereof. He shall see that all moneys due the Association are carefully collected

and without loss transferred to the custody of the Treasurer. He shall personally certify to the accuracy of all bills or vouchers on which money is to be paid. He is to conduct the correspondence of the Association and keep a proper record thereof, and perform such other duties as may be assigned to him from time to time by the Board of Direction.

## ARTICLE VII.

### COMMITTEES.

SECTION 1. The Board of Direction shall meet within ten days after each annual meeting, and shall appoint from among its Members a Finance Committee of three, a Library Committee of three and a Committee on Publications of three. These Committees shall report to the Board of Direction and perform their duties under its supervision.

SECTION 2. The Finance Committee shall have the immediate supervision of the accounts and financial affairs of the Association; shall approve all bills before payment, and shall make recommendations to the Board of Direction as to the investment of moneys and as to other financial matters.

SECTION 3. The Library Committee shall have general supervision of the Library of the Association and property therein.

SECTION 4. The Committee on Publications shall have general supervision of the publications of the Association.

SECTION 5. The Board of Direction may appoint such Standing Committees as it may deem best, to investigate, consider and report upon methods or appliances pertaining to the general question of railroad location, construction or maintenance.

SECTION 6. Special Committees to examine into and report upon any subject connected with the purposes of this Association may be appointed in the following manner:

A resolution to appoint such Committee, setting forth its objects and the number of its Members, may be presented by letter at any time to the Secretary of the Association, if signed by ten Active Members, and shall be referred by him to the Board of Direction, which, if it sees fit, may appoint such Committee. If the Board of Direction should not deem it expedient to appoint such a Committee, the Members requesting the appointment of such Committee shall be notified, and the matter will then be referred to the Association at its next annual meeting and decided upon by ballot. If two-thirds of the Members present vote in favor of such Committee it shall be appointed by the President.

## ARTICLE VIII.

### MEETINGS.

SECTION 1. The annual meeting shall be held each year at such place and at such time as may be selected by the Board of Direction. Twenty-five Active Members shall constitute a quorum. Other meetings of the

Association may be held at such times and at such places as the Board of Direction may select. The Secretary shall notify all Members of the time and place of all meetings of the Association at least thirty days in advance thereof.

SECTION 2. The Board of Direction shall meet at such times and at such places as a majority of the Board may determine. Five Members of the Board of Direction shall constitute a quorum.

SECTION 3. The order of business at meetings of the Association shall be as follows:

1. Reading of Minutes of last meeting.
2. Address of the President.
3. Admission of new Members.
4. Reports of the Secretary and Treasurer.
5. Reports of Standing Committees.
6. Reports of Special Committees.
7. Unfinished business.
8. New business.
9. Reading of papers and discussion thereof.
10. Election of Officers.
11. Adjournment.

This order of business, however, may be varied from, on a majority vote of Members present at any meeting.

SECTION 4. Discussions shall be limited to Members and to those invited to speak by the Presiding Officer.

## ARTICLE IX.

### AMENDMENTS.

SECTION 1. Proposed amendments to this Constitution must be made in writing and signed by not less than ten Active Members, and shall be acted upon in the following manner:

The amendments shall be presented to the Secretary, who shall send a copy of same to each Member of the Board of Direction as soon as received. If at the next meeting of the Board of Direction a majority of the Board are in favor of considering the proposed amendment, the matter shall then be submitted by letter to each Active Member of the Association for voting by ballot, and the result announced by the Secretary at the next annual meeting of the Association. In case two-thirds of the votes received are affirmative, the amendment shall be declared adopted. Amendments so adopted shall take effect thirty days thereafter.

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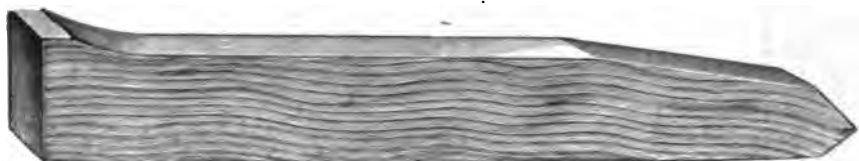
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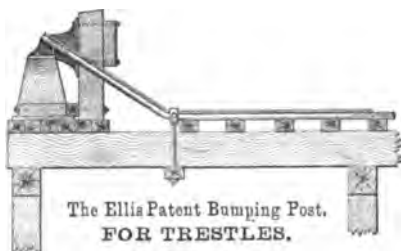
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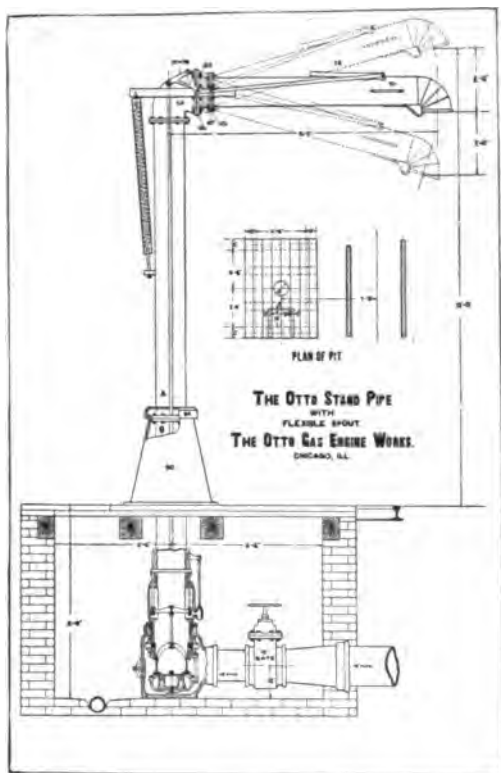
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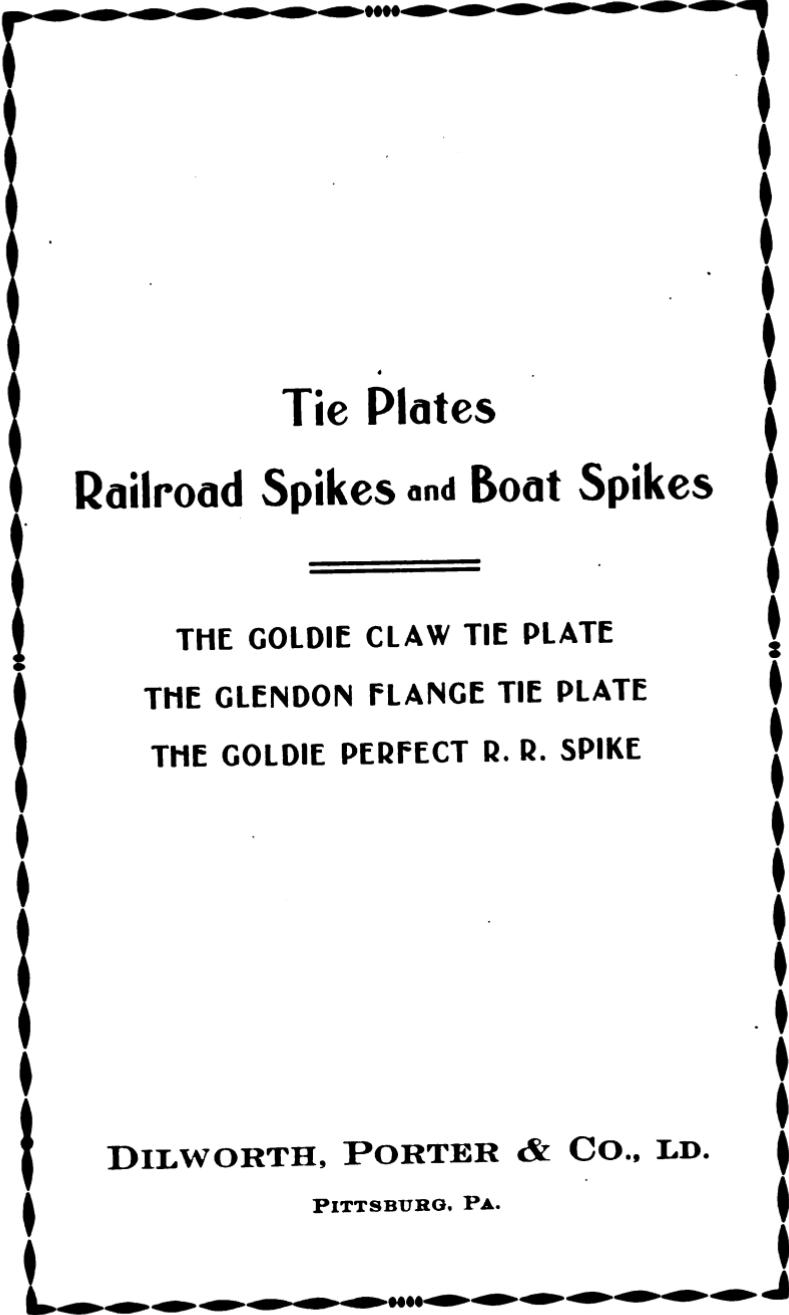


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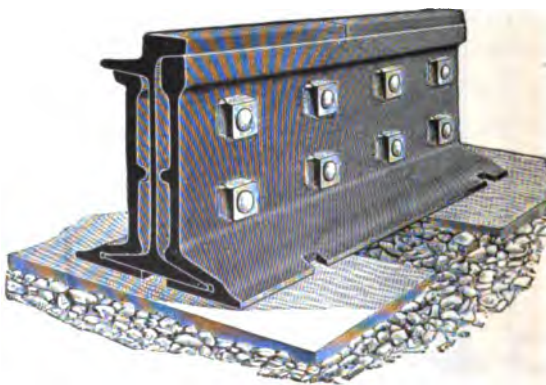
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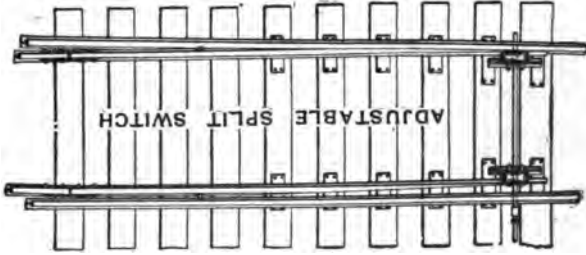
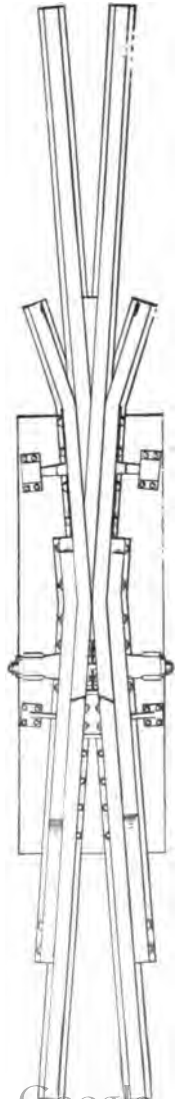
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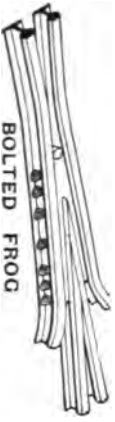
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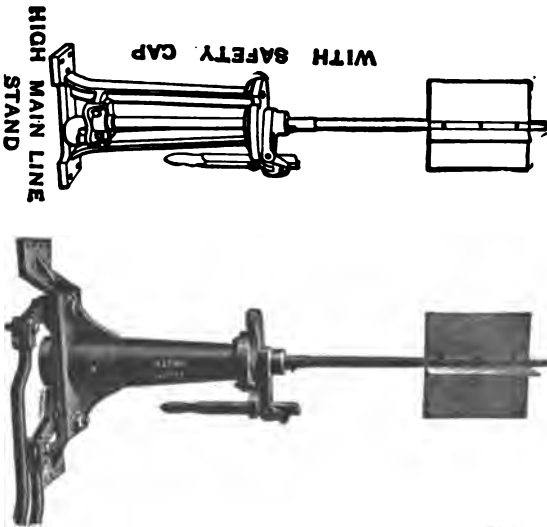
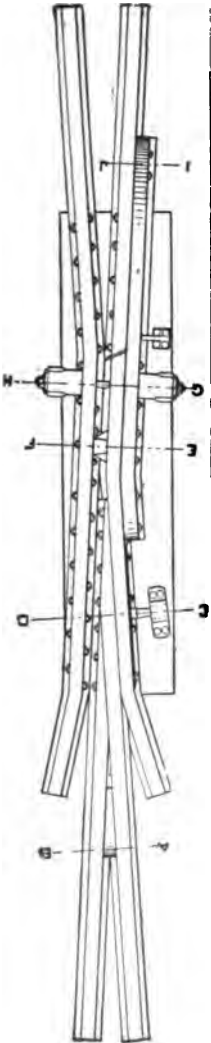
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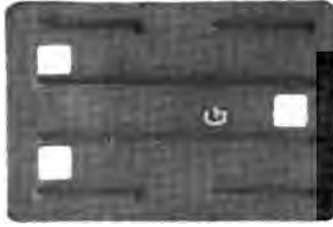
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This cut shows Metal Slates in connection with Roll-Ridge Coping, Plain Hip-Covering and Valley.

# WHAT CORTRIGHT ROOFING DOES

THE Cortright Metal Roofing is designed to avoid the heaviness, the expense and fragility of slate roofs; to avoid the lack of wearing qualities in the wood shingle, and to provide a substitute for the "buckling," rattling and expensive economy of the tin roof, and to increase the beauty of a roof. May we not mail you "Concerning that Roof," a 24-page and cover embodiment of metal roofing arguments?

## CORTRIGHT METAL ROOFING CO.

50 N. 23d St., PHILADELPHIA, PA.

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## EDISON-LALANDE BATTERY TYPE "SS"

**Leads Them All.      Stands the Cold Weather.**

**Especially suitable for Electric Semaphores, Railway Crossings and other Signaling Work.**

In a comparative battery test made by the Union Switch and Signal Co. during last winter, in which **all makes** of Caustic Soda Batteries on the market were subjected to the same conditions, the **Edison-Lalande Battery, Type SS, was the only battery that did not fail in the extreme cold weather**, but continued the signal without interruption until the charge was entirely exhausted. *Write for Catalogue No. 36.*

## EDISON MANUFACTURING CO.

Factory, Orange, N. J., U. S. A.

83 Chambers St., New York

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# STANDARD AUTOMATIC COAL CHUTES

FOR COALING LOCOMOTIVES

— ALSO —

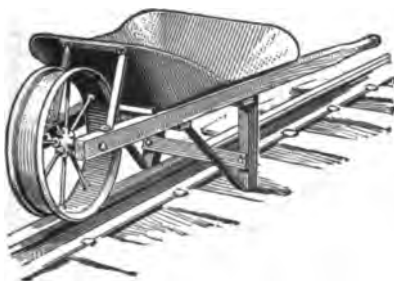
## The Tangent Under-Cut Balanced Gates for Overhead Storage Bin

Above the pockets into which coal is dumped, thus obviating all shoveling of coal. This system is the most reasonable in first cost, as cheap as any method of handling coal, and by far the quickest and most convenient method of putting coal into the locomotive.

For further particulars write to

**WILLIAMS, WHITE & CO. . . . Moline, Ill.**

A great many thousand of our Standard Coal Chutes are in use throughout the Western, Southern and Middle States, as well as on some of the Eastern roads.



## THE AMERICAN TRACKBARROW

Patented in U. S., Great Britain and Canada.

**Track Work Simplified and  
Results Largely Increased**

### Some of the Trackbarrow's Advantages:

One man is the unit of labor.  
He works all the time; no waits for trains in R. and M. of W.

He walks beside, not astride, the rail.  
Invaluable in construction work.  
It runs anywhere on earth, as well as on the rail.

It is very much cheaper and more convenient than push car, which it supersedes.

It does away with fifty yards' walk with a shovelful of dirt.

No danger attending its use.  
It is a Money and Labor Saver.

Write for Price List and  
Illustrated Description to

**THE AMERICAN TRACKBARROW  
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### Preferable to Push Car.

The following is from GEO. K. THORNTON, Road Master B. & M. R. R., Woodsville, N. H.: "I have used the Trackbarrow for moving small land slides out of cuts, and where trains are thick find it preferable to push car, as it saves flagging. It is also very handy in yards to move small supplies instead of using hand and push cars."

### Useful for Distributing Ballast.

From J. H. Reagan, General Road Master Grand Trunk Railway System, Battle Creek, Mich.: "I am using the Trackbarrows for distributing ballast on our new line around Flint, where too much gravel was unloaded in one place and not enough in others, and find them very useful for that purpose; this is being done on the rail. I have given a favorable report on them to our Superintendent."

# The Weber Railway Joint Mfg. Co.

## EMPIRE BUILDING, NEW YORK

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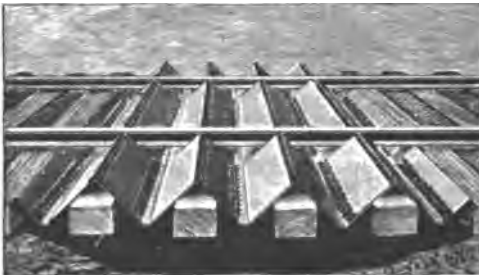
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The Ross Impassable Cattle Guard is a high-grade Steel Guard, finished in workmanship, and absolutely impassable to all stock.

Correspondence solicited.  
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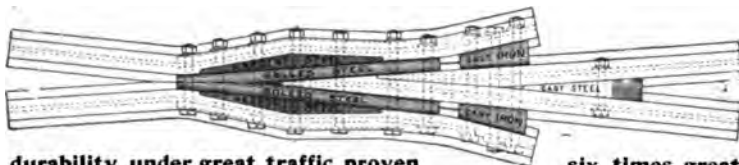
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# The PENNSYLVANIA STEEL CO. STEELTON, PA.

**STEEL RAILS** All weights and patterns for steam, street and electric railways, steel splices and rail fastenings.

**RAILWAY FROGS FOR TRACKS OF EVERY DESCRIPTION.** Special attention to frogs for main line tracks. Improvements brought out by this company are approved as **standards** on many of the most important railroads where extreme durability and safety are required.

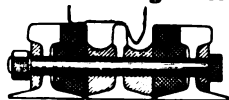
## THE ANVIL FACE FROG LEADS ALL



**Its durability under great traffic proven**

Its peculiarity consists of massive pieces of tool steel, tempered extremely hard on the surface, built into the frog, just where destructive wear occurs in ordinary frogs. See the sectional view showing the hardened steel pieces and their relation to wheels.

**six times greater.**



## RAILROAD CROSSING FROGS,

for the most exacting conditions or any degree of complication are a specialty. Good work and accuracy guaranteed. Large facilities.

**SLIPS** for crossing thoroughfare tracks of every angle. New improvements for operating slip switches and movable point frogs with certainty and dispatch.

## SPLIT OR POINT SWITCHES, Improved Patterns

Special attention to our new **REINFORCED CHALLENGE SWITCH**, which has the point rails reinforced and stiffened by a special form of angle and requires only one connecting bar, which may be adjustable or plain. We make also switches with usual number of connecting bars, of various types, now standard on many railroads. Parts usually welded are forged solid.

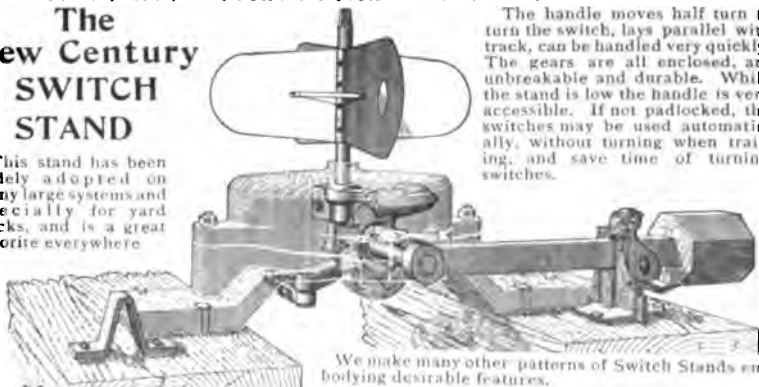
## Improved 3-throw (or Double-throw) SPLIT SWITCHES

Worked by one handle, and various other types, as required.

**SWITCHES, ETC., FOR STEAM TRACK IN PAVED STREETS A SPECIALTY.**

## The New Century SWITCH STAND

This stand has been widely adopted on many large systems and specially for yard tracks, and is a great favorite everywhere.

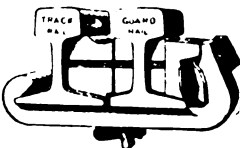


The handle moves half turn to turn the switch, lays parallel with track, can be handled very quickly. The gears are all enclosed, are unbreakable and durable. While the stand is low the handle is very accessible. If not padlocked, the switches may be used automatically, without turning when trailing, and save time of turning switches.

We make many other patterns of Switch Stands embodying desirable features.

## Pennsylvania Standard Guard Rail Clamp

Secures guard rail immovably on main track rail, applied without drilling. Flangeway may be varied for various gauges on curves or to compensate for wear of guard rail. Not disturbed when renewing ties or shimming.



# KENNICOTT WATER SOFTENER

On Chicago & Eastern Illinois Railroad, Rossville Junction, Ill.  
Capacity, 2,000 gallons per hour.



Grains scale-forming solids before treatment, 17.72; after, 3.97.  
Total pounds scale-forming solids removed per day, 352, or 5 tons each month.

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